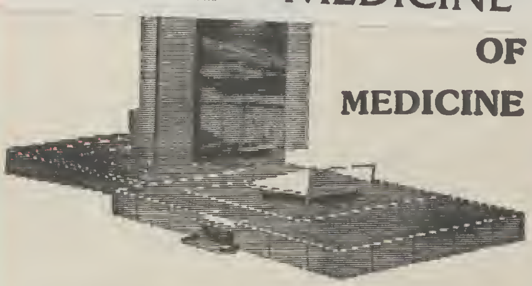


# ESSENTIALS
## OF
# ORAL SURGERY

BY

VILRAY PAPIN BLAIR, A.M., M.D., F.A.C.S.
Professor of Oral Surgery in the Washington University Dental School, and Associate Professor of Clinical Surgery in the Washington University Medical School, St. Louis

AND

ROBERT HENRY IVY, M.D., D.D.S., F.A.C.S.
Professor of Maxillo-Facial Surgery in the Graduate School of Medicine and Professor of Clinical Maxillo-Facial Surgery in the School of Dentistry, University of Pennsylvania, Philadelphia

WITH 335 ILLUSTRATIONS

ST. LOUIS
C. V. MOSBY COMPANY
1923

Printed in U. S. A.



*Press of*
*C. V. Mosby Company*
*St. Louis*

# PREFACE

For some time the authors have felt the need for a textbook containing the subject matter taught to their undergraduate students, and it is with this primarily in mind that the present volume has been undertaken. It will be observed, therefore, that greatest attention is paid to the *recognition* of surgical conditions of the mouth and jaws, with few details of the technic of major surgical operations. The dentist should understand the pathology and be competent in diagnosis of surgical lesions located in his field, but without special training is not called upon to perform major surgical operations in this region. At the same time, there are many less serious surgical procedures which come directly within the scope of the dentist, and these receive more detailed attention in the book. It will be observed that much of the material has been taken from Blair's "Surgery and Diseases of the Mouth and Jaws," the description of major surgical technic, however, having been omitted. To this has been added new matter on fractures of the jawbones, tumors, root resection, operations for cysts, and anesthesia.

In addition to its use as a textbook by students, it is hoped the book will serve as a guide to dental and medical practitioners in dealing with surgical conditions of the mouth and jaws.

V. P. B.
R. H. I.

## CONTENTS

# ILLUSTRATIONS

# ESSENTIALS OF ORAL SURGERY

## CHAPTER I

## EXAMINATION—ANATOMICAL CONSIDERATIONS

### EXAMINATION

The adult to be examined should, if possible, be placed in a sitting posture. The light, which may be direct or reflected from a head mirror, should be good. The hands of the examiner should be well washed, either in the presence of the patient or in an adjoining room, and the odor of tobacco, especially in examining women, should be entirely eliminated.

It is sometimes almost impossible to make a satisfactory examination of a struggling child, but patience and kindness will be successful in nearly every case. As a rule, children resist because they are frightened, and it is better to spend a little time in making friends than to risk prolonging strained relations by a forced examination. If the examination or treatment must be done forcibly, it is best accomplished by seating the child upon the nurse's lap, with its body well against her. With one hand pressed on the forehead, she holds the child's head against her shoulder or forehead; with the other arm she controls its arms and body.

Infants are best examined lying on the back on the nurse's lap, with the feet toward her body and the head hanging between her knees, with the face toward the examiner and the light. The arms may be swathed to the body by a large towel or sheet, but if this is done, it should be done effectually.

### MOUTH CAVITY

The mouth is a part of the face. The latter consists of a series of bony partitions, covered with soft structures, attached to the fore part of the under surface of the brain case. These partitions inclose spaces that contain either air or special organs. The mouth is most inferiorly situated of these facial spaces, is the beginning

of the alimentary canal, and an accessory air passage. With its contents, it is the organ of mastication, taste, and articulate speech (Fig. 1).

The teeth and gums separate the mouth cavity proper from an outer space, which is called the vestibule.

The palate, which is bony in its anterior five-eighths, forms the

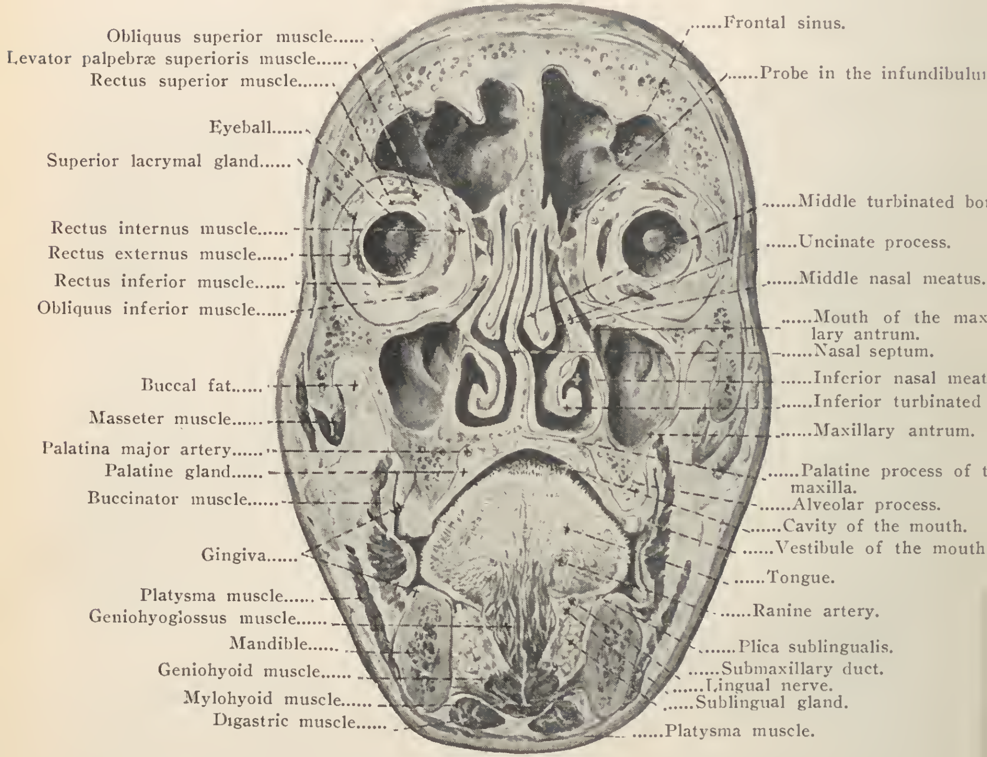



Fig. 1.—Coronal section through the face. (From Spalteholz.)

roof of the mouth, from which it separates the nasal fossæ and the nasal pharynx, and in some instances, from one or both of the maxillary sinuses.

Anteriorly and laterally the cavity is bounded by the alveolar processes and teeth of the upper jaw, and by the teeth, alveolar processes, and body of the lower jaw. Posteriorly it communicates, by the wide space between the fauces, with the shallow oral pharynx, which posteriorly rests on the bodies of the cervical vertebræ.

## FLOOR OF THE MOUTH

The floor of the mouth consists really of a muscular plane, which separates the mouth and its contained structures from the neck below. For convenience, however, the structures lying along its upper surface are spoken of as being in the floor of the mouth, and all of these, with their intraoral mucous covering, are referred to as the floor of the mouth.

The muscular floor is formed by geniohyoid muscles and the unpaired mylohyoid muscle, which stretches between two concentric bony arches from the concavity of the body of the mandible to the convexity of the body of the hyoid bone. Behind this, within the

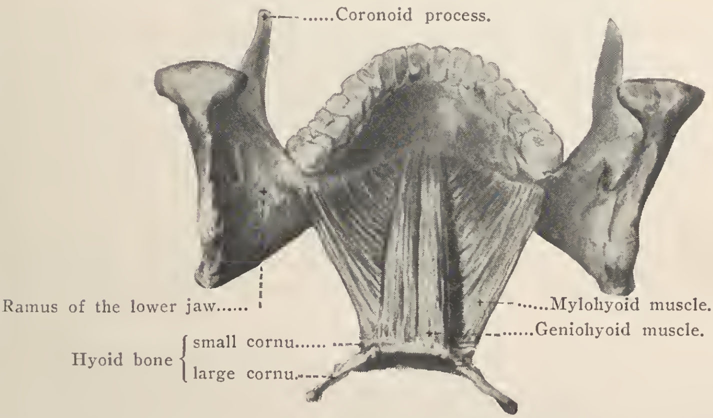



Fig. 2.—Muscles that form the floor of the mouth stretching between the concavity of the body of the mandible and the convexity of the hyoid bone.—From Spalteholz.

concavity of the hyoid bone, the air and food passages proceed downward from the oral pharynx into the neck. The lateral walls and most of the roof of the mouth are of unyielding tissue, and when closed, it is through the muscular floor that adjustment of capacity is accomplished (Fig. 2).

Except through a central vertical septum composed of the geniohyoglossi muscles, nowhere is the tongue in contact with the muscular floor. This is best illustrated by referring to coronal and sagittal sections of the mouth (Fig. 1). The space between the body of the tongue and the muscular floor is divided into two lateral compartments by this muscular septum. Each of these subspaces is bounded below by the muscular floor, externally by the body of the mandible, medially by the geniohyoglossi and geniohyoid mus-

cles, and above by the reflection of the mucous membrane upon which the body of the tongue rests. In these compartments are the structures that are spoken of as being in the floor. Anteriorly these spaces are limited by the mental portion of the mandible, while posteriorly, between the root of the tongue and the angle of the jaw, they open freely into the intermuscular connective tissue spaces of the neck. It is these posterior intermuscular spaces that afford entrance and exit to the vessels, nerves, and ducts that are found in the floor. Within the floor of the mouth are contained the lingual vein, lingual nerve, and submaxillary duct. The lingual artery lies buried in the under surface of the tongue. Within the floor of the mouth and in the under surface of the tongue are several excretory glands, mucous and salivary.

**Glands of Nuhn and Blandin.**—Blandin first described a gland lying on the under surface of the tongue, near the tip on either side of the midline, about the size of an ordinary almond. Each gland has one or two excretory ducts opening on the under surface of the tongue. Cysts, stones, and tumors occur in connection with these glands.

**Incisive Glands.**—Besides the glands of Nuhn and Blandin, Suzanne and Merkel have described a group of glands on either side, lying in front of the salivary caruncle and just behind the periosteum of the jaw.

Tillau and Fleischmann describe an inconstant sublingual bursa on either side between the geniohyoglossi muscles and the mucous membrane lying between the frenum and the sublingual gland. This has been credited as the cause of acute ranula. Merkel and others have denied the existence of this bursa.

**Bochdalek's Glands.**—Bochdalek's glands are certain remnants containing ciliated epithelium supposed to be derived from the thyroglossal tract, which is often called the thyroglossal duct. Chronic obstruction of the excretory duct of an incisive, a Bochdalek, or a sublingual salivary gland causes a cyst known as ranula.

The sublingual salivary glands consist of lobules lying on the floor of the mouth beneath the submaxillary duct. The submaxillary salivary gland lies mostly outside the mouth, beneath the mylohyoid muscle. Part of the gland, however, containing the common excretory duct, bends around the posterior border of this muscle, and comes to lie above the muscle within the floor. The duct is continued along the upper surface of the mylohyoid muscle and sublingual gland.

On either side of the junction of the frenum of the tongue with the floor is a small papilla, on which may be seen the openings of

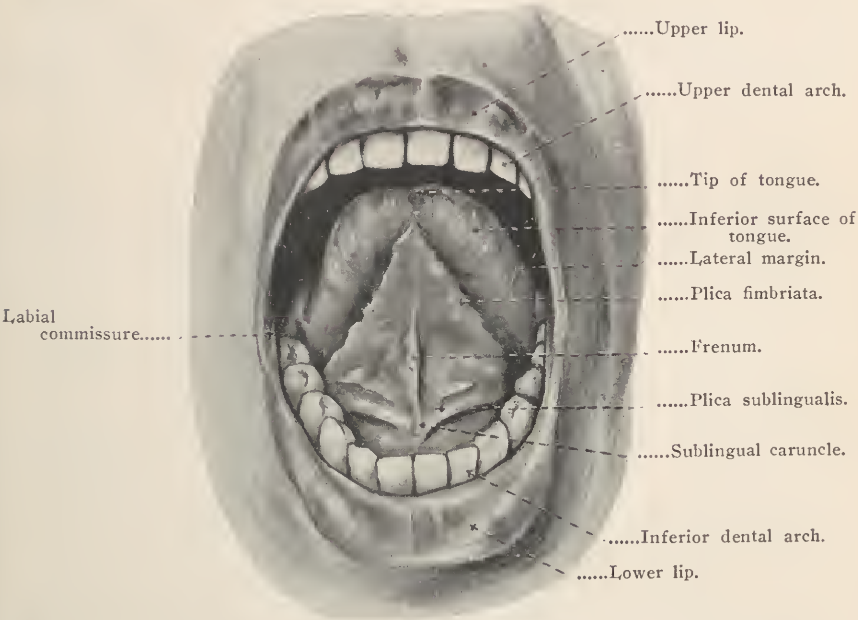



Fig. 3.—Mucous reflections under the anterior of the tongue. (From Spalteholz.)

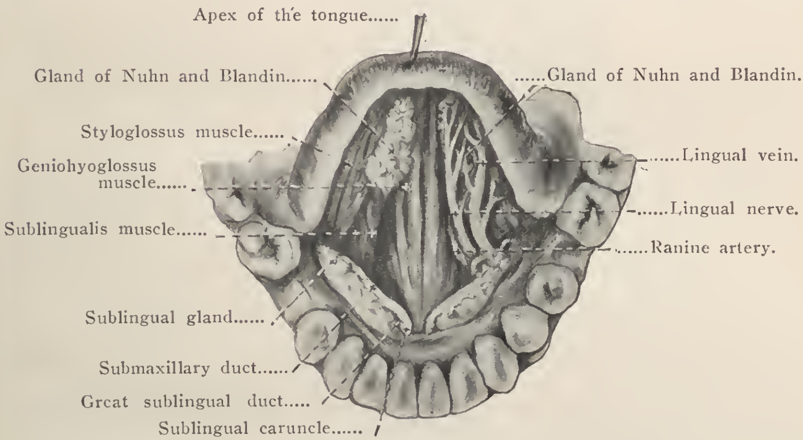



Fig. 4.—Structures lying beneath and within the anterior part of the tongue.—After Spalteholz.

the submaxillary ducts. Running backward from this, at the bottom of the sulcus, are two elevated ridges of mucous membrane, under which lie the sublingual glands, and through the crest of which the

sublingual ducts open (Figs. 3 and 4). These ridges, the plicæ sublinguales, also mark the course of the ducts of the submaxillary glands, the lingual nerve, and the lingual vein, which lie along the floor of the mouth to the median side of the sublingual gland. The lingual nerve enters the floor of the mouth from above, just to the inner side of the body of the mandible, and can be felt by pressing the tip of the finger against the bone below the last molar tooth.

With one finger in the sulcus and two fingers of the other hand thrust under the jaw from without, the sublingual gland in front, and the submaxillary gland, posteriorly, can be distinctly outlined, unless there is too much fat. In the normal condition the submaxillary duct cannot be felt, but a stone in the duct, or the thickening around it, can always be detected. In carrying on this examination of the floor, the mouth should be moderately open, with the head bent slightly forward, to relax the muscles of the floor and the platysma. The fingers of one hand should steady the structures while they are being palpated by the other. In examining for stone in the duct, it is possible to pass a probe into the duct from the opening in the papilla. The connective tissue in the floor of the mouth is very lax. In certain inflammatory conditions it may become rapidly infiltrated with serum until the mucous membrane is raised up in a roll above the level of the gums, and the tongue is pushed before it.

## TONGUE

The tongue in the normal state of rest is entirely within the mouth. The body occupies the upper portion of the cavity, and the dorsal surface presents an anteroposterior convexity that approximates a half circle. When the mouth is opened, the body follows the movements of the lower jaw (Fig. 5). It is anchored, by relatively small muscular attachments, posteriorly to the body of the hyoid bone and anteriorly to the symphysis of the mandible. Its mucous reflections and some extrinsic muscles further limit its excursion and determine its shape. Nowhere is it attached or supported by ligaments. The mobility of the tongue is further augmented by the fact that the hyoid bone is, in turn, dependent for its position entirely on the muscles to which it furnishes attachment.

Far back on the tongue, and best seen with a mouth mirror, is the sulcus terminalis, a scarcely visible V-shaped furrow on the dorsal surface. It runs from the attachment of the anterior faucial pillar,

on either side, backward and toward the median line to the foramen cecum, which latter marks the upper termination of the thyroglossal duct or tract. Slightly in front of, and parallel with, the sulcus terminalis is a V-shaped row of large taste papillæ, known as the circumvallate. These, by their supply through the glossopharyngeal nerve, are related to the pharyngeal portion of the organ.

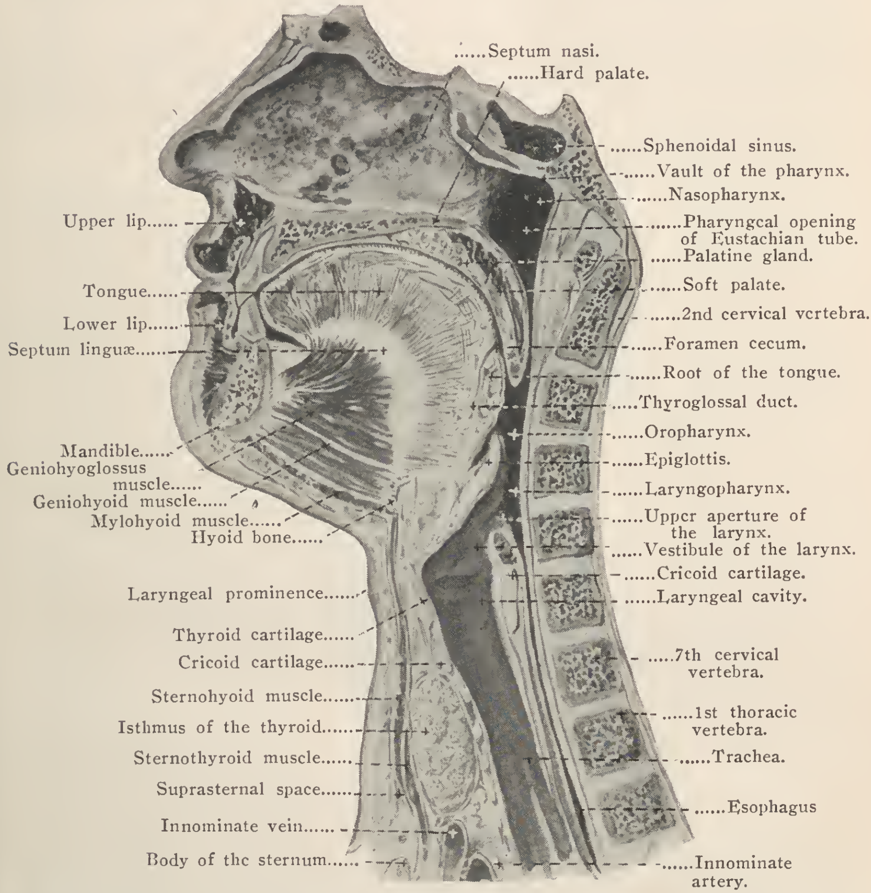



Fig. 5.—Sagittal section through the midplane of the face. (After Spalteholz.)

That portion of the tongue behind the sulcus is called the root, and is morphologically related to the pharynx; while that in front is the body, and is derived from the primitive buccal cavity. The root of the tongue forms most of the anterior wall of the oral pharynx.

The mucous covering of the pharyngeal surface continues on to

the fauces and the lateral pharyngeal walls. Below it is reflected on to the front of the epiglottis and forms the middle glosso-epiglottic fold. This part of the mucous membrane is much more sensitive to pain than that over the dorsum, and in examination, unless cocainized, should not be touched by the tongue depressor. The submucous tissue of this part contains mucous glands and heaped-up lymph follicles, the latter constituting the lingual tonsil (Fig. 6). This, with the faucial and pharyngeal tonsils, makes a complete ring of adenoid tissue surrounding the entrance of the

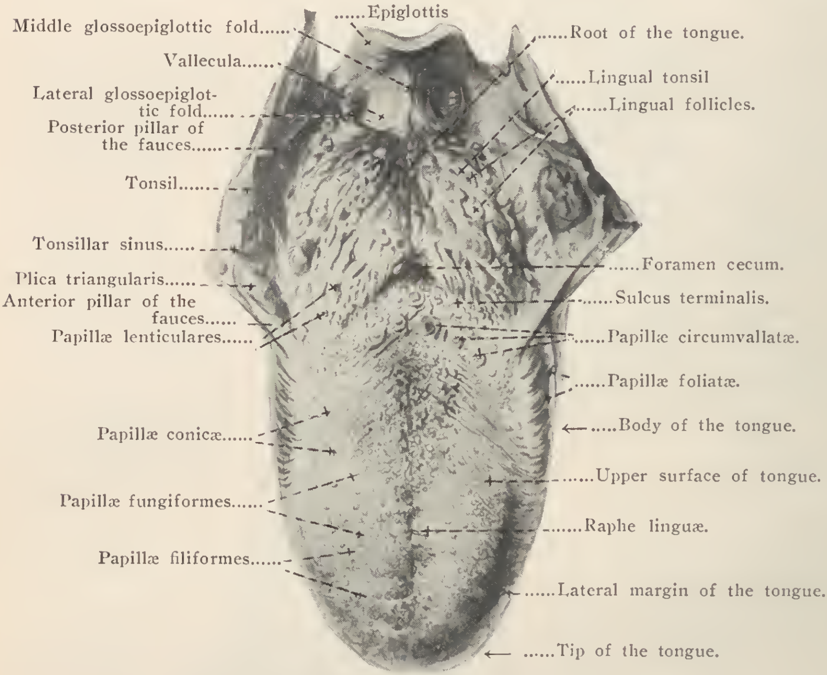



Fig. 6.—Dorsum of the tongue. (After Spalteholz.)

pharynx. There are also mucous glands on the dorsal surface, and lateral borders in the neighborhood of the sulcus terminalis and circumvallate papillæ, and any of them may give rise to a mucous cyst. Over the dorsum the mucous membrane is beset with taste papillæ. These give the tongue a rough appearance, which varies greatly under certain conditions.

The mucous covering is reflected from the dorsum around the borders to the inferior surface of the body, which latter it invests over the greater part of its extent. Thence the mucus passes to

and across the floor to the gum and fauces, and while it forms part of the anchorage of the organ, this distribution permits of great freedom of movement and also of digital examination of the body and of the floor separately.

On raising the tongue, it will be seen that the mucous membrane on the under surface is smooth in character, and that it is reflected to the bottom of the glosso-alveolar sulcus in a double fold, with a free border anteriorly (Fig. 3). At the posterior limit of this fold the membrane forms the posterior limit of the glosso-alveolar sulcus by becoming continuous with the lower gum and anterior faucial pillar behind the last molar tooth. In the anterior portion of this fold the two layers of mucous membrane inclose but little connective tissue, while posteriorly they are separated by the interposition of the geniohyoglossi muscles. Grasping this septum with the thumb and finger, the anterior border of the muscles can be felt. The anterior nonmuscular portion of the septum is called the frenum. It may be abnormally short from above downward, and its upper attachment may extend sufficiently forward to bind the tongue down in the sulcus. This condition is known as tongue-tie, and is rather rare. The opposite condition of too great laxity of the frenum has been reported to have caused death by suffocation by the tongue turning back into the pharynx.

Two elevated fringes may be seen on the under surface of the tongue, converging at its tip. These indicate the positions of ranine arteries. About 12 millimeters on either side of the frenum may usually be seen the terminations of the ranine veins. These, with other veins in the sulcus, may become varicose, in which case a mass of large dark veins is seen under the mucous membrane, almost obliterating the fore part of the sulcus. They are soft and yielding to touch, but fill as soon as the pressure is removed.

The surface in front of the circumvallate papillæ is the least movable part of the body of the tongue, and is therefore more apt to be coated. Unilateral furring has been noted in connection with irritations of the fifth cranial nerve of the same side, but as Mr. Hutchinson states, unilateral furring in the presence of toothache may be due partly to the instinctive immobilization of the tongue on that side. We have repeatedly observed unilateral furring in tic douloureux.

The mucous membrane of the tongue, like that of the mouth, is liable to a variety of superficial lesions. Aphthæ may form upon the tip and edges, thrush may occur in infants and adults whose health

is broken down, herpes is occasionally seen, and the ulcerative stomatitis may extend to it from the cheek or palate. In addition to these, however, and to various kinds of specific diseases—such as syphilis and tuberculosis—the tongue is especially subject to certain forms of chronic inflammation. Some are superficial, and spread over the greater portion; others are local, and end in deep ulceration. On the mucous surface of this part—or, in fact, over any part of the mouth—may develop one or more white sodden patches of leucoplakia, or a papilloma or nevus may be present.

The body of the tongue is composed almost entirely of intrinsic muscles. Between the two halves of the body is an incomplete fibrous septum corresponding to the median raphe. Butlin is inclined to regard this as analogous to certain fibrous or bony processes found in connection with the midplane of the tongue or body of the hyoid bone in certain lower animals. Occasionally fatty and cartilaginous masses have been found in connection with the median septum of the human tongue. It is a matter of clinical observation that cancer of one side of the body of the tongue is very slow to cross the median septum.

Foreign bodies may become imbedded in the body of the tongue. It may be the seat of gummata and many other infections. Dermoid cysts, lipomata, and fibromata occur in its substance, but these benign growths are rare. It is a favorite seat of cancer, which often develops from a papilloma, leucoplakia, or any chronic irritation, but sarcoma of the tongue is very rare. Abscess of the tongue is not common, but it contains sufficient connective tissue to allow great swelling; and it is sometimes subject to a congenital enlargement known as macroglossia. Congenital deformities of the tongue are very rare, the commonest being tongue-tie, and a median cleft of the body. The latter resembles that of some lower animal.

The tongue is plentifully supplied with blood, chiefly from the lingual arteries, which run near its inferior surface and which have but scanty intercommunication.

The lymphatics are especially large and numerous, and rapidly disseminate cancer cells. They drain from different areas into the submental, submaxillary, and superior and inferior deep cervical nodes. Special importance is attached to one superior deep cervical node situated a little above the bifurcation of the common carotid artery, which, on account of the numerous streams that reach it, has been called the principal node of the tongue.

The motor nerve supply of the tongue is mostly from the hypo-

glossal. Injury to this nerve or its center, or pressure on the nerve at its foramen of exit or any other point, will cause paralysis and atrophy on the affected side. When protruded, the tongue deviates toward the paralyzed side.

The tongue is well supplied with sensory nerves for both taste and common sensation. Tactile sensation is more acute on the tip than on any other part of the body. The sensory supply of the pharyngeal surface and the circumvallate papillæ is through the glosso-pharyngeal nerve from fibers originally derived from the trifacial. This latter nerve supplies also the oral part of the organ directly through the lingual. The taste papillæ on the tip, sides and dorsum probably send their afferent fibers through the lingual and chorda tympani nerves.

Painful affections of the tongue in the area supplied by the lingual nerve may be accompanied by severe neuralgia deep in the meatus of the ear through the connection of the fifth nerve with the seventh, or it may be over the terminal branches of the fifth. Spasmodic contractures of the muscles of mastication may result from the same reflex irritation of the fifth.

## PALATE

The palate presents a median raphe which ends anteriorly in the incisive papilla, which marks the opening of the anterior palatine fossa. In infants this papilla is connected with the frenulum of the lip. The raphe may be raised by a ridge of bone in the midline, the torus palatinus. Sometimes a small pit that will admit the point of a pin is seen on each side immediately behind the incisive papilla about 2 millimeters from the midline. These correspond to the lower openings of Stenson's canals.

In the region of the junction of the hard and soft palates is usually seen on each side of the raphe a small pit, the foveola palatina, which contains the excretory ducts of several palate glands. The palate ridges are confined to the anterior part of the hard palate.

The mucous membrane and periosteum of the hard palate are fused into a single layer, which is thickest at the edges and is rather insensitive. The vessels of the palate lie in its deeper portion, and the descending palatine arteries may be felt pulsating in the posterior part, close to the junction of the palate with the alveolus (Fig. 7). In the submucous tissue is a layer of mucous glands, which is thickest at the lateral border and at the junction of the

hard and soft palates. Large mucous glands are found on both surfaces of the uvula.

The soft palate, or velum, is composed of muscle and the palate aponeurosis. It is attached to the posterior border of the hard palate, and covered with mucous membrane on both surfaces. From the middle of its posterior border hangs a fleshy mass, the uvula, which helps to close the space between the posterior faucial pillars during the act of swallowing, etc. It may be absent, bifurcated, or abnormally large.

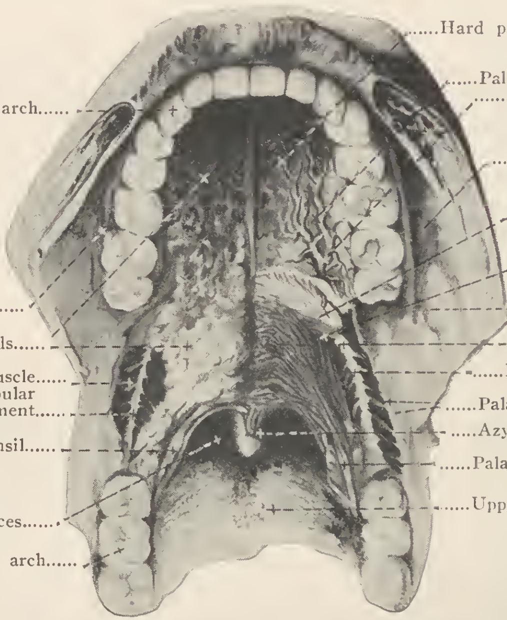



Fig. 7.—Submucous structures of the palate and faucial pillars. (After Spalteholz.)

The anterior faucial pillars, arching from the under surface of the velum 1 centimeter in front of its free edge, near the base of the uvula, pass downward and slightly forward to join the tongue a little in front of the middle of its lateral border. These are made up of the palatoglossi muscles, covered by mucous membrane.

The posterior pillars spring from the posterior border of the palate, and pass downward and slightly backward, to be lost in the lateral wall of the oral pharynx. They contain the palatopharyngei muscles. Between the anterior and posterior pillars lie the faucial, or oral, tonsils. Just behind the last upper molar tooth is the prominence of the maxillary tubercle, and behind that may be felt

the hamular process which surmounts the internal plate of the pterygoid process of the sphenoid bone. Over this hamular process plays the tendon of the tensor palati muscle.

The arch of the palate varies in height, width, and shape. Marked variations are usually credited to, or associated with, early mouth breathing. The palate may show a congenital longitudinal cleft in a part or the whole of its length. It may show the scars resulting from the surgical repair of such a deformity, or defects due to injuries or distinctive ulceration.

The velum or the fauces may be deformed by cicatricial contraction and adhesions resulting from destructive inflammations. The palate is a favorite site for gummata and resulting syphilitic perforations, and in some countries lupus and tuberculosis are not uncommon. Cysts and benign and malignant tumors are also found in the palate, and teratomata may be connected with it.

## FAUCES AND PHARYNX

When the patient breathes deeply through the mouth with the head thrown back, the soft palate is raised, the pillars are separated, and the uvula, tonsils, fauces, and walls of the oral pharynx are exposed. The arch of the atlas corresponds to the hard palate, and the body of the axis to the soft palate (Fig. 5). The upper four, in children the upper six, vertebral bodies can be examined with the finger. The posterior pharyngeal wall should rest firmly against the bodies of the vertebræ, but may be separated from them by a postpharyngeal collection of pus.

The palate, fauces, and oral pharynx in children are especially liable to injury from falling on sharp sticks. This may be followed by a condition of trismus, not necessarily tetanus, and requires an anesthetic to make a satisfactory examination. The lymphatics from the palate and upper part of the pharynx pass to the lateral pharyngeal and retropharyngeal and to the superior cervical nodes.

Besides the acute and chronic catarrhs, the pharynx is subject to secondary tuberculous ulcers, mucous patches, snail-tracked ulcers of secondary syphilis, diffuse gummatous infiltration, and localized submucous gummata. Benign tumors and both primary and secondary malignant tumors are also found in the pharynx.

The faucial tonsils are situated between the anterior and posterior faucial pillars, and rest on the superior constrictor muscle of the pharynx. When enlarged, the tonsil may stand out freely from the

pillars, or it may push the anterior pillar inward, in which case it is known as a buried tonsil. Often as much or more can be gained by palpating the tonsil as by inspection (Fig. 7).

Besides the enlargement of the tonsil itself from acute or chronic inflammation, there may be infection and suppuration of the peritonsillar tissue, with diffuse swelling and induration of the surrounding parts. If such a collection of pus bursts through the pharyngeal wall, postpharyngeal suppuration will result. Chancre, secondary snail-tracked ulcers, and diffuse gummata are the syphilitic lesions most commonly found. Fibroma, epithelioma, lymphosarcoma, and round-celled sarcoma are the tumors common to the tonsils.

The lymphatics from the tonsils drain into the superior deep cervical nodes. An enlargement of one of these, situated just behind the angle of the jaw, is so constant in tonsillar infections that it has been called the tonsillar node.

## TEETH

The crowns of the teeth rise free in the mouth above the gum margin. The anterior teeth have incisive edges, and are for biting off the food; while the posterior, the molars, are broad and have grinding surfaces. The teeth between these, the canines and premolars, are intermediate in character and function. Later in life, when the teeth are worn down, fairly good grinding surfaces are formed on the anterior teeth, which are very useful when the bicuspids and molars are lost. In most individuals the edges of the lower incisors are slightly overlapped by those of the upper, which gives them a scissors action. The crowns of the upper central incisors are wider than the lower, with the result that every tooth in the lower jaw, with the exception of the central incisors, is in relation with two teeth in the upper, and every tooth in the upper jaw, except the last molar, is in relation with two in the lower. This relation is in such a way that any cusp of any tooth in the lower jaw is slightly in advance of the corresponding cusp of the same tooth above (Fig. 8). In the molar region the buccal cusps of the lower teeth rest in the grooves formed between the buccal and lingual cusps of the upper. Any variation from this arrangement in the child, especially if the variation is in the occlusion of the first molars, should be referred to the orthodontist for examination.

The crowns of the teeth may be perfectly formed, or show the malformations resulting from early nutritional disturbances. Com-

mon among these is the Hutchinson tooth, which is best marked in the upper central incisors, and consists in a notching of the incisal edge and a globular shape to the crown. This has been supposed to be almost always caused by congenital syphilis. The crowns of the teeth may be of various sizes and shades of color, and the teeth may vary in form and number. They may be abnormally soft, and as a result of this in young people, or from continued use in older ones, the crowns may be worn away almost to their necks. The teeth may present all stages of caries from slight pits in the enamel to total destruction of the crowns and parts of the roots.

Unless the patient is scrupulous in the care of his teeth, and even then in certain individuals, the teeth will show deposits of tartar.

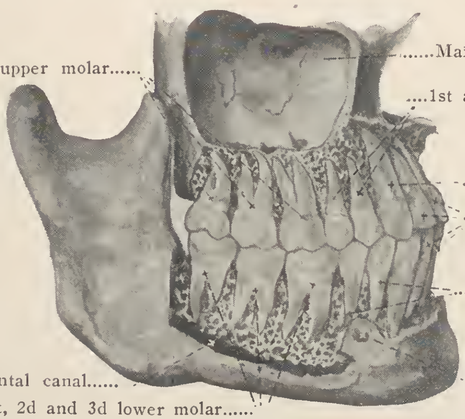



Fig. 8.—The occlusion of the teeth and their position in the jaw-bones. (After Spalteholz.)

This consists mostly of the precipitated calcium salts of the saliva, and therefore the deposits will be greatest on the lingual surfaces of the lower incisors and canines and on the buccal surfaces of the upper molars, these being exposed to the salivary streams from the submaxillary, sublingual, and parotid glands.

The nerves supplying the teeth are derived from the second and third divisions of the fifth nerve, the dental branches from which pass through bony canals in the substance of the maxilla and the mandible. They also receive fibers from the palatal, lingual, and buccal nerves. Caries or other irritations of the teeth, or direct irritation of the nerves in the bony canals, may cause reflex neuralgia along other distributions of the fifth nerve. It may cause spasm of the muscles of mastication. Spasm seems to be more

commonly associated with irritation of the third division than of the second.

In this regard the condition of the tooth pulp—whether healthy, inflamed, or dead—and the condition of the peridental membrane is often a matter of importance.

The diagnosis of the conditions of a tooth depends on changes of color, sensitiveness or lack of sensitiveness to certain stimuli, including the electric current, heat and cold, variations in translucency, and percussion note produced when struck with a metal instrument. To interpret these accurately requires the experience and training that belong essentially to the dentist. The most accurate method of diagnosing the condition of the pulp is by the use of the electric current as developed by Prinz.*

## GUMS

The gums may be inspected and palpated throughout their entire extent. They are composed of a mucoperiosteum, which surmounts the alveolar processes of the jaws. This covering resembles the soft tissue of the hard palate, and contains large mucous glands. These are especially numerous near the necks of the teeth, and any of them may give origin to mucous cysts. It is continuous with the mucous covering of the lips and cheeks on the outer surface, and with that of the palate and floor of the mouth on the inner. Around each tooth the mucofibrous tissue rises on the base of the crown, forming a collar which constitutes the gingival margin. For some distance from its occlusal edges, each tooth is in contact with the tooth on either side of it. Toward the neck the crown decreases in size, leaving the interdental spaces into which the gingiva extends, forming the interdental papilla. The periosteum descends into the alveolus as the peridental membrane, which performs its double rôle of covering the root and lining the socket.

The peridental membrane is of such consistency that, while it holds the teeth sufficiently firm for function, they are not perfectly rigid in their sockets, and an inflammation of this membrane will cause the teeth to rise and become abnormally loose.

Salivary calculus, which collects around the necks of the teeth, is one of the causes of chronic irritation of the gingiva, and brings about the recession of the gums so commonly seen. This irritation may open an avenue of infection to the peridental membrane, in

*Prinz: Dental materia medica, ed. 5, p. 563.

which case pus may be seen exuding from between the socket and root, and the teeth may become permanently loosened and lost. When advanced, this condition is called pyorrhea alveolaris, and is to be distinguished from an abscess in connection with the root, which discharges between the tooth and the soft tissue. Certain mineral poisons also predispose the gingiva to ulcerative inflammation, among which are mercury, phosphorus, and bismuth, while lead produces the characteristic blue line running along the gingival edge.

After an unchecked caries has attacked the dentin of the crown, it is apt to open into the pulp chamber, which is continuous with the root canal. This latter opens through the apical foramen into the apical connective tissue space of the alveolus, creating an open avenue of infection from the pulp chamber to the peridental tissue, which may result in any degree of inflammation or suppuration.

If properly treated by the dentist, such an abscess may sometimes be made to discharge through the root canal, but if neglected, it seeks the surface by one or two routes. In the incisor region it may occasionally discharge at the side of the root, so that the pus will be seen welling up around the neck. In all cases it will most likely perforate the alveolar process, and give rise to a subperiosteal abscess, which occasionally points toward the mouth, but generally toward the buccal cavity. In the upper jaw such an abscess, having perforated the bone, may burrow under the mucous membrane of, or perforate into, the maxillary sinus. Such abscesses are generally accompanied by considerable swelling of the face and marked constitutional disturbance. The acute pain is, for a time at least, relieved when the pus finds egress from the alveolus.

If the perforation is from the abscess surrounding the root of a tooth that has but a single root, as an incisor, it will almost always be on the labial surface of the alveolar process. In the case of a lower molar—which has two roots, one in front of the other—the perforation may be on either surface, usually the buccal. The first and second upper molars, however, have each three roots, one large one on the palate side and two smaller ones situated buccally. Infection from the tooth may travel through any of these roots, and therefore the perforation of such an abscess may be into the antrum or on the palate, or the buccal surface. In any event, the resulting abscess may be present at the time of the examination, or a sinus may lead down to a piece of dead bone or root, or to a chronic bone abscess.

In the lower jaw the dissecting up of the periosteum by pus is apt to be followed by extensive necrosis of the bone, but in the upper jaw caries or absorption abscess is more common. The presence of areas of necrotic bone may be verified by feeling with an ordinary probe, but caries is best detected by thrusting a sharp steel Gilmer probe through the gum tissue into the soft insensitive bone, or by use of the x-ray. Though the mucous covering of the gum is relatively rather insensitive, it is better to anesthetize it before making the punctures. A local tenderness, a submucous thickening, or an abnormally soft spot will generally be the guide for making such a puncture. In any of these conditions a radiogram is very helpful.

The gums may be the seat of leucoplakia, acute or chronic abscess, or mucous cysts. Very rarely in young people there is a chronic hypertrophy of the gums that may hide the teeth and greatly encroach upon the vestibule and mouth cavity (Fig. 142).

Epulis may be present on the gums in the form of a small pedunculated or sessile tumor arising from the peridental membrane or periosteum; or a sarcoma, osteoma, or fibroma may involve a large section of the gum and jawbone. Carcinoma, often secondary to carcinoma of the lip, cheek, or tongue, is common in old people, especially men.

## VESTIBULE OF THE MOUTH

The vestibule of the mouth is the space bounded by the lips and cheeks externally, and the teeth and gums internally. The muscular layer of the cheeks and lips is more or less closely attached to the outer surface of the jaws. The mucous lining is reflected on the alveolar processes, and is continuous with the gums. In the midline above, this reflection is drawn down in a fold which connects the upper lip with the gum. This fold, which is called the frenum or frenulum of the lip, may contain a nodule or may preserve the infantile arrangement of reaching to the incisive papilla. In the latter case it will cause a separation of the two central incisors. The frenum of the lower lip is not so marked as the upper.

Posteriorly, when the mouth is closed, there is a space behind the third molars and the maxillary tubercle, that will admit a 5-millimeter tube, through which the vestibule communicates with the cavity. When the mouth is widely open, the pterygomaxillary ligament can be felt stretching from the hamular process of the sphenoid bone to the inner side of the ramus of the mandible. Posteriorly the superior constrictor of the pharynx is attached to the full

length of the ligament, while anteriorly it gives attachment to the buccinator muscle, and through it these muscles are continuous with each other. The orbicularis oris muscle in front, the buccinators laterally, and the superior pharyngeal constrictor behind form a continuous muscular band which surrounds the vestibule and the oral pharynx. To the outer side of this ligament may be felt, in the order named, the anterior border of the internal pterygoid muscle, the whole of the anterior of the border of the ramus of the mandible and its coronoid process, and the anterior border of the masseter muscle (Fig. 246).

Temporal abscess may point into the upper fornix of the vestibule, between the coronoid process and the maxillary tubercle. In the upper fornix above the first molar may be felt the prominence of the malar process of the maxilla. In front of this prominence is the canine fossa, through which the antrum may be opened. Opposite the second molar tooth will be seen the papilla through which the duct of the parotid gland discharges. It admits a probe with difficulty. The cheeks and lips are everywhere closely applied to the gums and teeth by the tone of the buccinator muscle, which, in chewing, prevents the food from falling into the lower fornix. In palsy of the seventh nerve this power is lost.

The mucous membrane is everywhere closely adherent to the muscles of the cheeks, with but little submucous tissue. This accounts for the fact that in health it is seldom caught between the teeth.

There are a number of mucous glands lining the cheek, especially in the neighborhod of the last molar teeth, which are called the buccal glands. These may become cystic. Over the lips the submucous tissue contains a number of large mucous glands, which may be felt with the tongue, and which may be congenitally cystic or may become distended later. The cheek may present an acute or chronic traumatic ulcer, a papilloma, a patch of leucoplakia, or a carcinoma. Sarcoma of the cheek may be secondary to sarcoma of the jaw. The gums, lips, and cheeks may show recent noma or its resulting scars. Dense scars from this or other causes, situated in the oral surface of the cheek, may materially limit the separation of the jaws.

## LIPS

The lips surround the entrance to the vestibule, which is the rima oris. Here they are covered with a modified mucous membrane, which begins where the integument changes color at the outer mar-

gin. This membrane ends posteriorly just behind the line along which they meet when closed, where it merges into the ordinary mucous membrane of the vestibule. It contains numerous simple vascular papillæ, in which its nerves terminate, and which renders this part of the lip exquisitely sensitive to pain. It contains no hair follicles, but especially near the skin line are numerous sebaceous follicles which may become the seat of minute retention cysts, or the starting point of rodent ulcer. The lips themselves are made up of skin, fatty superficial fascia, the orbicularis oris muscle, submucous tissue, and mucous membrane. The two lips converge at the angles of the mouth, which are situated opposite the first bicuspid teeth. The line of closure of the lips is slightly curved, and is just below the middle of the upper incisor crowns. The size of the rima oris varies in individuals, and seems to be related to the size and prominence of the teeth.

The orbicularis oris, which surrounds the aperture, is a circular muscle, which has very slight bony connections, but is closely attached to both the mucous membrane and the skin. It receives fibers from and constitutes the insertion of every muscle of the face that converges to the mouth, including the buccinators, and accounts for the infinite variety of expressions and contortions of which the lips are capable. The laxity of the lips favors plastic operations, but is also partly responsible for the distortion caused by scars that follow destructive inflammations. The lips contain a large amount of connective tissue, and are capable of immense swelling that may be dependent on injury, infection, or angioneurotic edema.

The blood supply of the lips is mostly from the coronary arteries, which form an elliptical anastomosis around the mouth near the deep surface, and which can usually be felt pulsating under the mucous membrane. In falls on the lips, they are easily cut by the teeth, and the blood may be swallowed, thus giving rise to the surmise of some internal injury. The facial vein continues above with the ophthalmic, and neither contains valves, which accounts for the comparative frequency with which facial infections cause septic thrombosis of the cavernous sinuses. The cutaneous surface of the lips in both sexes is closely beset with hair follicles, that may become the starting point of carbuncle. The lymphatics of the lip drain into the submental and submaxillary nodes. The sensory supply is of the fifth nerve—the upper lip through the infraorbital, the lower through the long buccal and inferior dental. The motor supply of all the muscles of the face is from the seventh cranial nerve. Com-

plete unilateral paralysis causes a characteristic drawing of the mouth to the opposite side and inability to close the eye.

The lips and oral slit are subject to a variety of malformations. The lower lip especially may be subject to congenital enlargement due to lymphatic hypertrophy. There may be enlargement of the upper lip in children, associated with labial fissures. In both children and adults enlargement of the lower lip may be due to syphilis. The skin of the lips immediately surrounding the mouth may be covered with fine radiating scars of syphilitic origin. The lips are the common seat of nevi of various sizes, and the mucocutaneous edge of the lip is the most common site of herpes, fissure, extragenital chancre, and epithelioma. Papillomata of the lip have been known to become cornified, and even to develop true protruding horn. Either lip may be congenitally cleft.

## MANDIBULAR JOINT

Passing the finger backward along the lower border of the zygoma, the condyle of the mandible is distinctly palpable just in front of the ear. Pressing gently on this point with two fingers while the mouth is being opened, the condyle is felt to travel first downward and forward, and then straight forward as it travels on and then across the articular eminence. As the limit of excursion is approached, there may be a slight click, a loud cracking, or even a locking of the condyle on the eminence. The latter is a subluxation. The condyle may be dislocated into the pterygoid fossa, in which event the mouth is held rigidly open. When the mouth is wide open, a deep hollow can be felt in the position that is occupied by the condyle when the mouth is closed. By violent force transmitted through the jaw, such as a fall on the chin, the condyle may be driven through the tympanic plate of the temporal bone into the middle ear or upward into the middle fossa of the skull, constituting the backward or upward dislocations.

This joint, on one or both sides, may be replaced by a true ankylosis, or the movement may be limited by fibrous tissue. If ankylosis has existed during the period of growth, it will interfere with the development of the mandible and cause retraction of the chin. The joint may be the seat of any of the affections to which true joints are subject. Suppuration in the joint is more apt to spread anteriorly or posteriorly than externally or medially on account of the relative thickness of the capsule in these various surfaces.

On account of its proximity to the middle ear, the pus may invade that cavity, or vice versa.

There may be mechanical interference with normal action of the jaw, or there may be paralysis or spasticity of one muscle or a group of muscles, or certain members of several groups. The former condition may be due to one or more of several causes. A tumor may mechanically interfere, or the joint may be the seat of true or fibrous ankylosis, or of exostosis. The condyle or interarticular cartilage may be dislocated, or scars may bind the bone in any part. In certain fractures the jaws cannot close voluntarily. The limitation may be voluntary, to avoid the pain it would induce as the result of inflammation or an injury. Muscle spasm may be caused by central irritation or peripheral irritation along the distribution of its own or associated nerves; almost never by disease within the muscle. Paralysis is aways caused either by a central lesion or some interference in the course of the motor-conducting paths to that muscle.

## JAWS

The jaws should be examined on all exposed surfaces. With the exception of the sigmoid notch, all of the borders and most of the surfaces of the mandible may be palpated. The maxillæ, with the malar bones, are almost equally accessible to the examining fingers. In seeking for obscure fractures, care should be taken not to increase the original damage in the effort to obtain crepitation. Gentle manipulation is all that is ever permissible, and is usually sufficient. Pressure applied at the angles will cause pain at a fracture, and such a hint should be sufficient.

The portion of the alveolar process may be broken from either jaw. Fractures of the maxillæ are usually impacted, and crepitus is rarely present. One maxilla may be broken loose, or there may be a complete transverse fracture through both bones, so that the upper jaw hangs from the cranial base only by the soft tissues. Fractures of the maxillæ may extend into the oral, orbital, or nasal cavities, or into the maxillary antrum, or may injure the superior maxillary nerve, the nasal duct, or branches of the internal maxillary artery. Through its intimate associations with the nasal passage and accessory cavities, fractures of the maxilla may be followed by emphysema of the cellular tissues of the face.

With advancing age, as the teeth are lost, the alveolar processes

are absorbed. When entirely gone, plates for artificial teeth are worn with difficulty. As their function is lost, the muscles of mastication atrophy, and with them the bone that serves for their attachment, so that the angle of the jaw appears to gradually open out and the body to lengthen. Loss of teeth and alveolar processes gives the peculiar shortening of the lower part of the face and the prominence of the chin often seen in old people.

The jaws may present deformity resulting from maldevelopment, necrosis, or malunion of fracture, and are subject to a variety of cysts and tumors.

Among the tumors of the upper jaw are fibroma, enchondroma, osteoma, myeloid sarcoma, round- or spindle-celled sarcoma, and cancer. The last is secondary, usually to cancer of the mucous membrane of the mouth or antrum. In the upper jaw, mucous cysts of the antrum and dental cysts are the varieties usually found. The lower jaw is subject to the same tumors as the upper, but myeloid sarcoma is much more common. The common cyst of the lower jaw is a dentigerous cyst, while multilocular cysts also hold this as their site of election. Actinomycosis is commonest in the neighborhood of the lower jaw, and both jaws may be involved in leontiasis ossea.

Fractures of the mandible are not impacted, and those of the body are usually compound, owing to the inelastic character of the mucoperiosteum covering the gums. We have seen one impacted fracture of the mandible, but regard it as a surgical curiosity.

**Maxillary Sinus.**—The maxillary sinus, or antrum of Highmore, is situated in the body of the maxilla. The upper wall of the antrum is the floor of the orbit, the inner wall is part of the outer wall of the nasal fossa, the outer wall is the facial surface of the maxillary bone, and the inferior wall is the base of the alveolar process. It communicates through a small opening in the hiatus semilunaris with the middle meatus of the nose. This opening is at the upper part of the antral cavity, and free fluid, usually pus, can drain through this opening only when the head is held downward or to the opposite side. The infraorbital nerve runs in the upper wall of the antrum, and its anterior and middle dental branches course downward in canals in the outer wall. The nasal duct, which conducts the tears from the lacrymal sack to the inferior meatus of the nose, runs through its inner wall. The apices of the roots of the molar teeth, of one or both of the premolar teeth, and some-

times of the canine tooth, are in close relation with its floor and may extend up into the cavity. Malignant growths tend to infiltrate through the wall, while cysts and benign tumors may thin the wall and push it outward. Cysts may arise from the mucous glands of the interior, or may be the extension upward of dental cysts—rarely dentigerous cysts. The outer wall may become so thinned that digital pressure will cause a crackling, or fluctuation may be felt. Aspiration or puncture of the antrum is done through the inferior meatus of the nose, the canine fossa, or, when a suitable tooth has been recently extracted, through the alveolus. The antrum may be examined by palpation, transmitted light, x-ray, aspiration, and exploration. Infection from the roots of the teeth in relation to it may cause suppuration between the mucoperiosteal lining and the bony wall, may infect the mucous cavity directly, or may even cause infection of the orbit.

Tumors that arise in the antrum may grow in any direction. When inward, they obstruct the nose and the nasal duct; inward and backward, they obstruct the nasopharynx; upward, they infringe on the orbit, causing exophthalmus and neuralgia; outward, they cause swelling of the face, with neuralgia; and downward, cause downward arching of the palate, loosening of the teeth, and toothache.

## MUSCLES OF MASTICATION

When tense, the masseter muscle can be distinctly felt, and often seen, on the outer surface of the ramus. The temporal muscle can be felt while chewing, and by pressing with the finger just above and in front of the ear. As mentioned, the anterior border of the internal pterygoid can be felt in the mouth, but the external pterygoid muscle cannot be palpated.

In tetanus the masticatory muscles are usually the first and most constantly involved, but spasm of these muscles may result from intraoral irritations, especially those located over the distribution of the third division of the fifth nerve. The spasm may be clonic or tonic.

Paralysis of the muscles of mastication will follow any injury of the motor root of the fifth nerve, and commonly an operation on Gasserian ganglion or its root for facial neuralgia.

## SALIVARY GLANDS

**Sublingual Gland.**—The sublingual gland, lying between the mylohyoid and the geniohyoglossus muscles, and covered by the mucous floor of the mouth, has already been noted. It has a number of ducts, and contains no lymph nodes.

**Parotid Gland.**—The parotid, the largest of the salivary glands, lies just in front of the ear, behind and overlapping the ramus of the jaw and masseter muscle. When inflamed, it causes the swelling that is characteristic of mumps. The space in which the gland lies is increased when the head is held erect, with the mouth closed and the jaw thrust forward, and advantage should be taken of this while making an examination. It is impossible to feel the substance of the gland in the normal condition. It seems to be peculiarly liable to infection in some epidemics of typhoid fever, and may also become infected by local injury, or through its duct. The gland is incased in a dense fascia externally and below, but internally, at the upper part, the sheath is lacking, and the parotid space communicates with the deep connective tissue spaces of the pharynx. Retropharyngeal abscess may infect the gland, or pus from the gland may burrow into the space, into the temporal fossa, down into the neck, or into the external auditory canal; but it rarely points superficially. Virchow has reported cases of intracranial infection from parotid abscess along the branches of the fifth nerve.

The duct of the parotid gland, Stenson's duct, runs through the cheek a finger breadth below the zygoma to turn toward the mouth at the anterior border of the masseter muscle, where it can be distinctly felt when the muscle is made tense.

Besides the external carotid artery and external jugular vein, the parotid gland contains the seventh nerve, the auriculotemporal branch of the fifth nerve, and filaments from the great auricular nerve of the cervical plexus. Facial paralysis or neuralgia of the temple or upper part of the anterior surface of the pinna may result from infection or tumors of the parotid gland. It also contains a number of lymphatic nodules, which receive their efferent vessels from the eyelids, eyebrows, root of the nose, upper part of the cheek, the frontal and temporal part of the scalp, the outer surface of the ear, the tympanum, and possibly from the mucous membrane of the nose, the posterior alveolar region of the superior maxilla, and the soft palate. Its afferent vessels pass into deep cervical nodes. Tumors of the parotid are usually of a peculiar

variety known as salivary gland tumors. They arise from the body of the gland or detached nodules, most commonly in young adults, grow slowly or remain stationary for years, and then may take on rapid infiltrating growth. Some sarcomata of the parotid grow rapidly from the first.

**Submaxillary Gland.**—The submaxillary gland lies under the side of the jaw, in front of the angle, and is inclosed in a complete capsule. Part of the posterior end of the gland turns around the posterior border of the mylohyoid muscle and lies in the floor of the mouth, and it is from this part that the duct is given off. Unless there is too much subcutaneous fat, the normal gland can usually be palpated by feeling in the floor of the mouth with one finger while the gland is pressed up from below with the other hand. The facial artery grooves its deep surface. While the vein crosses superficially, its sheath contains lymph nodes—usually only the superficial layer. These receive lymphatics from the lips, middle of the dorsum of the tongue, and the floor of the mouth, and are sometimes the secondary starting point of a fulminating infection in the neck—Ludwig's angina. Primary growths of the submaxillary are rarer than in the parotid, but stone in its duct, with secondary inflammation of the gland, is very much more common

## LYMPH NODES

The lymph nodes are always of interest. It is comparatively seldom that they are the seat of primary disease. Secondary enlargement, however, almost constantly follows infections of the areas which they guard, and they form the first barrier to infectious material that has escaped into the lymph streams.

The lymph nodes that concern the mouth and upper part of the pharynx are grouped as follows:

The lingual nodes lie between the geniohyoglossi muscles above the mylohyoid. They are small and rarely palpable.

The suprahyoid or submental lymph nodes are situated in the anterior part of the digastric triangle, below the chin and above the hyoid bone. They are apt to become enlarged in disease of the tip of the tongue, the midpart of the gums or floor of the mouth, the midpart of the lower lip or chin. They send their lymph partly into the submaxillary nodes and partly into a node situated on the anterior surface of the internal jugular vein, at the level of the cricoid cartilage. The infrahyoid nodes lie in front of the internal

jugular vein, between it and the omohyoid muscle, just above the point where this muscle crosses the carotid sheath. They are supposed to drain the neighborhood of the frenum of the tongue.

The submaxillary group lies under the deep cervical fascia, just below the border of the mandible on each side. They are usually superficial to the submaxillary gland, but rarely one may lie beneath it. A large node is usually situated near the facial artery. This receives streams from the side of the nose, the upper lip, the outer border of the lower lip, the anterior third of the lateral border of the tongue, the gums and teeth, the submaxillary and sublingual glands, and the adjacent parts of the floor of the mouth. This discharges into the upper deep cervical nodes, mostly into those in the neighborhood of the bifurcation of the common carotid artery.

The retropharyngeal glands lie behind the nasopharynx, and receive lymph from the nasal cavities and the accessory air sinuses, the nasopharynx, Eustachian tube, and adjacent structures. Their efferent vessels run to the upper deep cervical glands. From their position they are rarely palpable.

There are a variable number of nodes situated along the course of the internal maxillary artery. These rarely, if ever, are palpable, and receive streams from the orbit, the zygomatic and temporal fossæ, the cerebral meninges, the nose and palate, and discharge into the upper deep cervical nodes.

There are a few nodes in the superficial fascia of the cheek, and also superficial to the parotid gland. They drain the superficial structures of the upper part of the face and ear, and empty into the superficial and deep cervical nodes. According to Cunningham, there may be present a lateral nasal node situated between the ala of the nose and the cheek. The deep parotid nodes were described with the parotid gland.

The superficial cervical nodes are upon or imbedded in the deep cervical fascia along the course of the external jugular vein. They drain from the superficial tissues of the neck and the superficial parotid and submaxillary nodes. The lymph streams from all of these are emptied into the deep cervical nodes, which are arranged in two groups. Those along the common carotid artery and internal jugular vein, which constitute the deep cervical group, lie under the sternomastoid muscle. The others, which are disposed in the posterior triangle of the neck behind the sternomastoid mus-

cle, are called the supraclavicular group. They all finally empty their lymph streams into the general blood stream at the junction of the internal jugular and subclavian veins.

While the above indicates the normal course of the lymph streams, all the vessels are connected, and when any group of glands and vessels becomes blocked with pathological material, the lymph will seek other and more roundabout courses, so that finally all the neighboring groups of nodes may become involved from a single primary lesion.

## CHAPTER II

# STUDY AND DIAGNOSIS OF DISEASES

**Disease** is any alteration of the structure or the composition of the tissues, which impairs or tends to impair their function (Wagner).

A consideration of diseases from the standpoint of the clinician involves a systematic study under the following heads:

1. **Definition.**—It is usual to begin with a definition, describing the disease in a short sentence.

2. **Etiology.**—By etiology is meant investigation of the cause of disease. Causes of disease are usually divided into (a) predisposing, which tend to influence the individual's susceptibility to disease, and (b) exciting, which include the direct factors bringing about the disease. In the case of pneumonia, for example, exposure to cold is a predisposing cause, while the direct or exciting cause is infection with the pneumococcus.

3. **Pathology.**—Under pathology is included a study of the changes in the tissues and functions of the body taking place during the course and as a result of the disease.

4. **Symptomatology** is a study of symptoms and signs of disease. A *symptom* is a circumstance or manifestation occurring in a disease and serving to point out its nature. Symptoms may be (a) subjective, that is, manifest to the patient, or (b) objective, which are only brought out by physical examination of the patient. Objective symptoms are also known as physical signs.

5. **Diagnosis.**—By diagnosis is meant the determination of the nature of a case of disease by study of the history, symptoms, physical signs, and laboratory data. Thus, we speak of a *clinical diagnosis,* based on the history and symptoms of the case, and a *pathological diagnosis,* based on the laboratory findings.

6. **Differential diagnosis** is the process of exclusion of other diseases that may simulate the one in question.

7. **Prognosis** is the forecasting of the course and outcome of any given case of disease.

8. **Treatment** or **therapeutics** which includes all the measures which may be employed to cure or relieve the patient.

The making of a correct diagnosis is about three-fourths of the battle with almost any case of disease, and most failures in treatment are due to the fact that a correct diagnosis has not been made. Aside from the ordinary diseases of the teeth themselves, there are many conditions manifesting themselves in the mouth which it is of the utmost importance that the dentist recognize, first, because he will often, either by the examination incidental to dental operations, or by the patient's directly consulting him, be the first to see professionally an ulcer, lump, or other lesion in the mouth upon the early diagnosis of which may depend the health and perhaps the life of the patient; second, because some of these conditions are contagious, and failure to recognize them entails danger of infecting himself and also other patients. The dentist should therefore be familiar with, and recognize the indications for the carrying out of, the various clinical and laboratory procedures that may be demanded in the diagnosis of each individual case. Men with a great deal of experience can often tell at a glance what a given lesion is, but in many cases all the methods known to us have to be employed before a diagnosis can be made. The beginner at least must have firmly fixed in his mind a definite order and method of investigation. Later he will be able to suit his examination to particular cases that present themselves, but at first, the definite rules should be adhered to in order that nothing of importance be overlooked. It is important that a written record be made at the time of examination, for the sake of future reference.

The diagnosis can often be made with probability, if not always with absolute certainty, by clinical methods alone. A scientific and absolutely certain diagnosis can nearly always be made by a combination of clinical and laboratory methods.

The methods employed in arriving at a diagnosis are:

(1) The history of the patient. This includes name, age, sex, occupation, social condition (single, married, widow), chief complaint, habits, family history, previous medical history, history of the present trouble.

(2) Examination of the affected part and adjacent region.

(3) General physical examination.

(4) Laboratory methods.

For diagnosis it is not always necessary to carry out as complete an examination as outlined. As experience is gained, the essential things among those mentioned, as bearing on the individual case, will be looked into.

Let us now go further into detail as to the application of the points enumerated above, to the diagnosis of disease manifesting itself in the mouth.

(1) **History of the Patient.**—After obtaining the name and address of the patient, we question him as to his *chief complaint,* i. e., the trouble for which we are consulted, which immediately draws our attention to the site of the disease and the line of investigation to be adopted. Probably most frequently the chief complaint will be pain, of a certain character, in some particular region. In other cases it may be the presence of a swelling, of an ulceration, of bleeding, and so forth.

The *age* of the patient is important in many cases. Cancer usually appears in middle-aged or old persons.

*Sex.*—Cancer of the mouth is much more common in men than in women, so is leucoplakia.

The *occupation* sometimes forms an important clue to the diagnosis. Several forms of metallic poisoning with manifestations in the mouth are acquired directly through the occupation of the individual, e. g., lead poisoning.

*Habits.*—Chronic irritation of the mucous membrane of the mouth is frequently produced by excessive use of alcohol and tobacco, in the form of leukoplakia. Persons of unsanitary habits of living are more predisposed to mouth infections.

*Family History.*—Inquiry should be made as to the parents, whether living and well, or if dead, cause of death. The same applies to sisters and brothers and children. Tuberculosis of parents or members of the immediate family is of great significance as denoting probable constant exposure of patient to infection. In a child suspected of syphilis, the parents should be examined for this disease. In hemophilia, the tendency to bleeding usually occurs in males, but is inherited through the mother.

*Previous Medical History.*—In case of a suspected late or tertiary syphilitic lesion, inquiry may reveal that the patient has had a primary sore and other manifestations of syphilis. A history of several stillbirths in a woman is very significant of syphilitic infection. In suspected tuberculous ulceration of the mouth, the patient may give a history of suffering from a cough or other symptoms of pulmonary tuberculosis for a considerable period of time.

*History of Present Trouble.*—The patient should be questioned as to when and how the disease began, its rate of growth, whether getting better or worse, whether painful or not. Benign tumors increase

in size very slowly, may be present for several years, are usually not painful. Malignant tumors usually give a history of only being present a few months or weeks, grow rather rapidly, and are usually painful. Inflammatory conditions usually have only existed for days or weeks, undergo almost daily change, and are painful. In malignant tumors and tuberculosis there is usually a loss of weight and strength, and inquiry should be made as to the general health of the patient.

(2) **Examination of the Affected Part and Adjacent Region.**—The affected part may show a swelling or an ulceration or a sinus discharging pus. In the case of a swelling, the size, shape and color are noted by inspection. By palpation one determines whether the swelling is hard or soft, whether it has an elastic feeling, whether fluctuation due to fluid is present, whether there is tenderness, whether there is undue warmth. In the case of ulceration, the number of ulcers present, the shape, depth, color, regularity or irregularity of edges, size, etc., are determined by inspection. Palpation reveals whether the base of the ulcer is hard or soft, tendency to bleed easily, tenderness. The origin of a sinus discharging pus may be determined by probing. The neighboring lymph nodes should be examined.

(3) **General Physical Examination** of the patient may throw a great deal of light upon the nature of the local mouth condition. In early carcinoma there may be no effect on the patient's color and nutritive condition. Later there may be a peculiar pallor (cachexia) from anemia and intoxication, and emaciation.

In late syphilis, the patient may be poorly nourished and in addition to mouth lesions, scars or marks of syphilitic lesions may be found in other parts of the body.

In suspected tuberculous ulceration of the mouth, the patient is usually emaciated and shows signs of anemia and general weakened condition. Examination of the lungs may reveal evidences of tuberculosis there, as the mouth condition is nearly always secondary to the lung disease.

(4) **Laboratory Examinations.**—Very frequently, as already stated, we can come to a fairly accurate conclusion as to what is the matter with a patient by clinical methods alone, but occasionally we are very greatly helped by various laboratory methods, including the use of the x-ray and pathological examinations. Radiographic examination is an invaluable means of diagnosis in practically all lesions involving bone and teeth. By pathological laboratory methods we are very greatly helped both in the diagnosis of the lesion

itself and also in forming an accurate idea of the general condition of the patient. The latter knowledge is obtained in part by examination of the urine, which gives information as to the condition of the kidneys, and of the blood, by which we determine the presence of anemia, and whether the patient has the power to resist the infection, whatever it may be. As bearing directly on the diagnosis of the lesion present in the mouth, certain laboratory procedures are of especial value. Smears and cultures examined bacteriologically may determine the nature of the causative agent, as the spirillum and fusiform bacillus in Vincent's angina, the Treponema pallidum in the primary stage of syphilis, streptococcus infection, etc. Inoculation of guinea pigs with scrapings from a tuberculous ulcer may establish the diagnosis. A portion of the tissue from a tumor or edge of an ulcer may be removed under local anesthesia, and the diagnosis made by microscopic examination. In the secondary and later stages of syphilis, the diagnosis may be made by the presence of a positive Wassermann reaction in the blood.

The foregoing indicates briefly the various measures that are carried out in diagnosing pathological lesions in the mouth. The accompanying table illustrates the practical application of these methods to the diagnosis of three of the commonest causes of chronic swelling or ulceration within the mouth:

| | EPITHELIOMA | SYPHILIS | | TUBERCULOSIS |
|---|---|---|---|---|
| | | Chancre | Gumma | |
| Age | Middle-aged or old | Young adult usually | Any age | Any age |
| Sex | Male | Either | Either | Either |
| Occupation | No influence | No influence | No influence | No influence |
| Habits | Irritation from tobacco, alcohol, bad teeth | | | Unhygienic surroundings |
| Family history | Little or no influence | No influence | May be inherited from parents | Predisposition may be inherited. May be contracted from other members of family. |
| Previous medical history | Little or no influence | No influence | History of earlier manifestations, stillbirths, etc. | Chronic cough or other signs of pulmonary tuberculosis. |

| | EPITHELIOMA | SYPHILIS | | TUBERCULOSIS |
|---|---|---|---|---|
| | | Chancre | Gumma | |
| History of present trouble | Small nodule or ulcer getting larger slowly, several months, starting in one place. Pain. General health affected later. | Small lump which ulcerates, requiring ten days to two weeks for development. Little or no pain. Usually single lesion. | Begins as deep-seated painless lump, which later breaks down and ulcerates. May be similar lesions in other parts of body. | Single or multiple ulceration increasing more slowly than syphilis but more rapidly than carcinoma. May or may not be painful. Generally loss of weight and strength and signs of pulmonary tuberculosis. |
| Examination of affected part and adjacent region | Single ulcerative lesion, irregular edges, considerable surrounding induration. Very often associated with leukoplakia. Submaxillary lymph nodes enlarged late in the disease. | Single nodule, size of dime or quarter, with crater-like ulcer. Cartilaginous hardness of base. Little or no pain. Rather rare. Submaxillary lymph nodes involved very early. | Deep swelling or gangrenous ulcer. Not indurated. Little or no pain. Lymphatic involvement rare. | Irregular ulceration, which may be single or multiple. Generally no induration. Tender to touch. Peculiar granular appearance. Cervical lymph nodes may or may not be involved. |
| General examinations | May be no involvement of general health at first. Later may show toxemia and anemia | No involvement of general health | Anemia. May show evidences of other syphilitic lesions | Patient usually emaciated and anemic. May be evidences of pulmonary tuberculosis. |
| Laboratory examinations | Examination of tissue gives characteristic microscopical picture. | Treponema pallidum found in smear. Wassermann reaction usually not positive before fourth week. | Wassermann reaction positive in over 90 per cent of cases not under treatment. | Tissue shows characteristic microscopical picture. Sections may show tubercle bacilli. Tubercle bacilli usually present in sputum or in scrapings from ulcer. |

CHAPTER III

# INFECTION, INFLAMMATION AND ITS SEQUELAE

## INFECTION AND IMMUNITY

The term **infection** is applied to morbid conditions caused by the entrance and growth within the body of pathogenic microorganisms and to the act or process by which disease is thus produced (Hektoen). The manifestations of infection are brought about by microbic poisons (toxins), and in the case of some bacteria introduction into the body of the toxins alone will bring about all the characteristic signs of infection with the corresponding organism.

## MODES OF TRANSMISSION OF INFECTIVE AGENTS

There are many ways through which the germs of infection are carried from one person to another. One way is through the dust-laden air, though this is not so common a mode as was once supposed. In coughing, talking or sneezing, droplets of sputum and saliva containing disease microbes may pass from one person to another. This is one of the commonest ways of transmitting the specific organisms of pneumonia, diphtheria, whooping cough, tuberculosis, and pyogenic infections. Some diseases, such as typhoid fever and dysentery, may be transferred through drinking water. The bacillus of tetanus naturally inhabits the soil, and infection may be brought about through wounds coming in contact with this source. Food may be a means by which microbes may enter the body and cause infection.

Animals may be the means of causing human infection by harboring infectious germs that are directly transferable to man, or they may act as the intermediary hosts for disease germs.

## PLACES OF ENTRANCE OF INFECTIOUS MICROORGANISMS

The principal places of entrance for microorganisms causing infection are wounds of the skin and mucous membranes, the tonsils, the teeth, the intestines and the genital organs. The unbroken skin or mucous membrane is impervious to infection, but wounds, though

ever so slight, may be important factors in giving entrance to pathogenic organisms. The tonsils frequently afford entrance to the causative agents of many diseases, particularly various forms of streptococci, the diphtheria bacillus and the tubercle bacillus. The teeth are common portals of entry, particularly to streptococci, either through the root canal and apical foramen, or via the gingivae and peridental membrane.

**Mixed Infection.**—By mixed infection is meant the simultaneous entrance and action of two or more species of pathogenic bacteria. These are most commonly observed in parts of the body which are exposed to the air, such as the mouth, throat, etc. Wound infections are often mixed. An infection at first may be due to only one form of organism, but later have grafted upon it another variety resulting in **secondary infection**. In infections diseases generally, the advent of secondary infection increases the danger to the patient.

## MECHANISM OF INFECTION

The action of pathogenic microorganisms is due to substances formed by the bacteria known as *toxins*, which in some instances (tetanus, diphtheria) it has been possible to separate from the organisms producing them, and which can cause the same effects upon the body as the organisms themselves. In the case of most organisms, the harmful effects are not due to soluble toxins, but to poisonous substances (endotoxins) within the protoplasm of the bacteria themselves, and therefore it is necessary that these forms of bacteria themselves enter the body in order to produce infection.

## RESISTANCE AND SUSCEPTIBILITY

In the production of infection, besides the direct action of the pathogenic microbes, the important factors of resistance and susceptibility on the part of the individual have to be taken into consideration. There may be local conditions which favor resistance to infection such as unbroken skin, acid reaction of sweat, presence of antagonistic saprophytic bacteria, etc. Susceptibility, on the other hand, is favored by mechanical injury (wounds), alterations in the secretions, nutritional disturbances (cutting off of blood or nerve supply), etc.

The internal defences of the body consist in protective agents

found in the blood and lymph streams. These antibacterial substances act in several ways. One way is by direct solution of the bacteria by the substances in the blood (bacteriolysis). Other forms of antibacterial substances (opsonins) act by preparing the bacteria to be ingested by leucocytes (phagocytosis). General natural resistance may be diminished in several ways. Exposure to abnormal temperature, overwork, alcoholism, anemia, undernourishment, preexisting infections, all increase susceptibility to infection. A point of lowered resistance *(locus minoris resistentiæ)* such as injury, inflammation, maldevelopment, etc., often is the deciding factor in the localization of bacteria already circulating in the blood stream. For example, an individual may have a mouth infection such as a chronic alveolar abscess from which some of the bacteria are absorbed into the blood stream. Apparently all goes well until the individual receives a bruise, for example, over the knee joint, this being followed by an acute suppurative arthritis of the knee. In this case the rather insignificant injury afforded the *locus minoris resistentiae* which gave opportunity for the mouth bacteria to settle and do mischief.

The **effects** of infection are local and general. The local effects are mainly inflammatory. The general effects vary with the type of organism present. Most pathogenic organisms produce leucocytosis, or increase in the number of polymorphonuclear leucocytes circulating in the blood. Instead of the normal total number of leucocytes of 7500 per cubic millimeter, this may rise to 15,000 or 20,000 or higher. Normally, the polymorphonuclear leucocytes constitute 65-70 per cent of the total leucocytes. In leucocytosis, there may be an increase to 90 per cent or more. Leucocytosis must be regarded as a defensive measure on the part of the individual, as the white blood cells act as phagocytes, and are also one of the sources of antibacterial substances.

Some infections are characterized, not by a leucocytosis, but by an actual *decrease* in the number of leucocytes present in the blood stream, or *leucopenia*. Typhoid fever affords the commonest example of this type of reaction, which is probably due to the fact that the chemical response to the typhoid toxin lies in substances other than those furnished by polymorphonuclear leucocytes. The *anemia* so often present in infections is no doubt frequently due to the formation of substances by the bacteria which dissolve red blood corpuscles (hemolysins).

## SELECTIVE ACTION

Many pathogenic organisms and their poisons have a special affinity for the nervous system, causing neuritis, and other lesions. Others act more especially upon the heart and circulatory system. The work of Gilmer and Moody, Rosenow, Hartzell and Henrici, and others, has shown that infection by certain streptococci through diseased teeth in some cases shows a special affinity for the joints (arthritis), in others for the heart valves (endocarditis), etc.

**Fever,** which practically always accompanies acute infection and is due to the entrance of foreign protein into the body, may be taken as an index of the resistance of the individual.

## MECHANISM OF IMMUNITY

By the term *immunity* is meant the resistance manifested by man and various animal species to infectious microorganisms or other foreign proteins. Two kinds of immunity are recognized, natural and acquired.

**Natural Immunity.**—The natural or spontaneous resistance of the animal organism to disease is only relative, never absolute. It is probably dependent upon the presence of natural antibacterial substances in the body fluids.

**Acquired Immunity.**—Acquired immunity is that condition of protection against disease, resulting from recovery from infection or arising by virtue of artificial inoculation.

It has long been known that recovery from an attack of certain diseases confers protection against a second attack of the same disease, the classical example being smallpox. This is due to a cellular reaction resulting in the production of substances known as *antibodies* which neutralize the harmful action of the invading organisms. The bacterial derivatives which give rise to the formation of these protective specific antibodies are known as *antigens*. Different antigens produce different types of antibodies. *Antitoxins* are antibodies that combine with and thus neutralize the effects of the toxins of bacteria. The deleterious action of the diphtheria and tetanus bacilli is counteracted chiefly by means of antitoxins. *Lysins* (bacteriolysins) are specific antibodies which have the property of dissolving bacteria. *Opsonins* are antibodies in the blood serum which prepare bacteria for ingestion by leucocytes (phagocytosis). *Agglutinins* are substances that cause bacteria to draw together in clumps and lose their motility.

Immunization of animals to specific infections may be artificially carried out for the prevention or cure of disease. By *active* immunization is meant the artificial stimulation of the organism to produce antibodies so that it will be able to resist a specific form of infection. This is brought about by injection into the animal of small doses of killed or nonvirulent bacteria of the variety against which protection is desired. For example, to protect the body against typhoid fever, the individual is given several doses of killed typhoid bacilli, which will produce sufficient antibodies to protect the individual from an attack of the disease. The principle involved in vaccination against smallpox is the same. Hence the suspensions of various forms of bacteria used in these inoculations have come to be called *vaccines*. Vaccines are also in some cases employed during the course of an infection for curative purposes, as well as for protection. The source of the bacteria from which a given vaccine is made may be the tissues of the individual to be protected (autogenous vaccine), or the vaccine may be made up from a stock culture of the particular species of bacteria with which the individual is infected (stock vaccine). As a general rule, autogenous vaccines are more efficient than stock vaccines.

In *passive immunization* the antibodies themselves are injected into the animal which is to be protected. The antibodies or antitoxins are prepared by injecting another animal with the toxins of bacteria, and then withdrawing its blood serum which contains the antitoxin. Passive immunization has been most successfully employed in protection from, and cure of, diphtheria and tetanus.

Thus we see that the difference between active and passive immunization is that in the former the animal to be protected manufactures its own antibodies, while in the latter the antibodies are supplied by a second animal. Sometimes combined active and passive immunization is employed.

A knowledge of the principles of immunity has an important practical value to the surgeon in the treatment of infections.

## INFLAMMATION

**Definition.**—The phenomenon of inflammation is so complicated that it is difficult to define in a single sentence. Briefly, it is the reaction exhibited by live tissues to irritation. Under this broad heading is included not only the reaction to microbic infection, but also to mechanical, thermal, or other irritation. To produce inflammation,

the irritant must be directly or indirectly continuous in its action. After an irritant ceases to act, the process is simply one of repair.

**Etiology.**—Anything that causes local injury to the tissues is a cause of inflammation. These causes may be grouped as follows: (a) Microbic; (b) mechanical; (c) physical (thermal); (d) chemical.

(a) *Microbic.*—Microorganisms are the direct exciting cause of inflammation in the majority of cases. They gain access to the part either through a break in the surface of the body or through the blood stream from some other region of the body.

(b) *Mechanical,* i. e., trauma of various kinds, such as wounds, bruises and fractures.

(c) *Physical or thermal,* including extremes of heat and cold, and electricity.

(d) *Chemical.*—Under chemical causes, strictly speaking, should be classed the poisons of bacteria. Any chemical agent which will destroy tissue cells is a cause of inflammation. Strong antiseptics may act in this way.

The intensity of the inflammatory reaction varies greatly in individual cases and is dependent upon two variable factors, (a) the virulence of the irritant, and (b) the resistance of the tissues.

## THE INFLAMMATORY PROCESS

The inflammatory process may be studied microscopically in two ways: The first way is to watch the circulatory changes that take place in the web of the living frog's foot or mesentery. The second way is by injecting a culture of staphylococcus aureus subcutaneously into a series of rabbits, killing them at successive stages of the process, and preparing sections of tissue taken from the site of inoculation for microscopic study. In inflammation of the mesentery of the living frog circulatory changes are noted as follows:

1. Primary contraction of the blood vessels, and increase in the rapidity of the current.
2. Dilatation of the vessels and gradual slowing of the current.
3. Temporary or permanent arrest of the blood current *(stasis).*
4. Emigration of leucocytes through the vessel walls into the surrounding tissues.
5. Exudation of blood serum, and diapedesis of red blood corpuscles.

There is a primary contraction of the blood vessels, due to the irritation. This causes a temporary increase in the velocity of the blood-

current. The vessels now gradually dilate and the current becomes slower until it is almost entirely arrested. These phenomena are observed solely in the veins and capillaries. The slowing of the current is believed to be due to changes in the endothelial coat of the veins. While the current is flowing rapidly, the individual cells of the blood cannot be distinguished, but as it slows down, the leucocytes are observed to accumulate in the outer zone of the current, along the walls of the veins, some of them being fixed there. The leucocytes also tend to cling to the walls of the capillaries. This is known as *margination* of the leucocytes. After a time the leucocytes are observed to be making their way through the vessel walls. The first indication of this is the appearance of a small portion of the cell on the outer side of the vessel wall, gradually followed by the whole cell. This passage of the leucocytes through the walls of the veins and capillaries is known as *emigration.* While the emigration of leucocytes is going on, red cells and blood serum find their way into the surrounding tissues, principally through the walls of the capillaries. The extravasation of red cells is known as *diapedesis.* The inflammatory changes occurring outside the vessels are best studied in the tissues of the rabbit inoculated with a culture of staphylococcus aureus. A few hours after inoculation more leucocytes than usual are observed outside the vessels, and the cells of the part have become more prominent. Numerous polymorphonuclear leucocytes are massed around the bacteria, while mononuclear leucocytes are found in large numbers about the periphery of the infected area. There is a battle going on between the bacterial invaders on the one hand and the white blood cells and the fixed connective tissue cells on the other. There may be one of two outcomes, (a) *suppuration,* or (b) *resolution.* (a) If the bacteria prove too strong for ~~the defensive forces~~, near the center of the mass, distintegrative changes are seen in the cells, such as fragmentation of the nuclei and poor staining qualities. Finally, all tissue structure is lost and is replaced by fluid pus. (b) By resolution is meant a gradual subsidence of the inflammatory process and return to normal. The bacteria disappear from the outer zone of infection, being destroyed by the leucocytes and taken up by them and the fixed connective tissue cells (phagocytosis). The area of inflammation becomes gradually smaller in size, the leucocytes become fewer in number as they return to the circulation via the lymph spaces. At this stage the process of repair may be said to begin. New blood vessels are seen extending toward the center of the area of tissue destruction, followed by the appearance of numerous

oval and spindle-shaped cells—the fibroblasts, which are the precursors of connective tissue cells. Finally, the destroyed tissue is replaced by newly-formed connective tissue.

## SYMPTOMS OF ACUTE INFLAMMATION

The five classical or cardinal symptoms of inflammation, handed down from the time of Hippocrates, are: (1) heat (calor); (2) pain (dolòr); (3) redness (rubor); (4) swelling (tumor): (5) disturbance of function (functio laesa). The redness and heat are due to the increased blood supply; the swelling, to the dilatation of the vessels and infiltration of the tissues with plasma and blood cells, and in some instances to the increase in the number of fixed tissue cells. Pain is not an essential symptom of all inflammations, but is rather constant in the acute stages. There are many subacute and chronic inflammations in which no pain occurs. Pain seems to be due, at least partially, to pressure, but it is well recognized that the passive congestion and edema that accompany an inflammation, to a certain extent, allay pain. It is safe to state that the pain is in part caused by the irritant, and not wholly by the inflammation.

The disturbance of function is the direct outcome of the swelling and pain, and of the destruction of the specialized cells of the part by the inflammatory process.

In addition to these typical symptoms of inflammation there are others that nearly always accompany the process. Among these may be mentioned *edema*, or pitting on pressure of the surface covering the inflamed area. Another symptom is a *throbbing* of the part with each beat of the heart.

## TREATMENT OF ACUTE INFLAMMATION

After an infection has once gained a foothold in the living tissues, we must in our treatment regard not only the infection but the inflammatory processes that it has excited. We are not certain that the inflammatory process itself ever needs treatment, and we do know that there are very few, if any, infections that could ever be overcome without inflammation. Inflammation is Nature's way of fighting infections, and we must work with it, not against it; for otherwise our efforts will be in vain.

There are a few infections that we can overcome by saturating the body with a poison that will not destroy the tissues. Among

these may be mentioned malaria, which may be killed by quinine, and syphilis, which may be killed by mercury or salvarsan. When an infection is superficial, it may be influenced by locally applied antiseptics, such as alcohol, essential oils, iodoform, silver salts, etc. With a few isolated exceptions, however, treatment consists, at least in part, in promoting or regulating the inflammatory process.

One of the first requisites is the regulation of the body functions, especially the excretory organs. In the presence of an infection, the parenchymatous cells of various organs may become sluggish in their action and may require stimulation. The most common instance of this treatment is the administration of a purge and a stimulation of the skin by bathing. Next comes the establishment, as far as possible, of physiological rest of the affected part. Nature gives a strong hint in this regard in the pain that results from exercising an inflamed part. This rest should include the proper quota of sleep, and it may be necessary to administer an analgesic or a soporific. If the disease is at all prolonged, careful attention must be given to the nourishment of the patient. During this time the tissue waste is often greater than ordinary, and the ability to assimilate food is lessened; therefore food should be given in an easily digested form.

Prolonged high fever is very detrimental, but it is not proper to continuously give antipyretics to reduce it. Bathing reduces the fever, stimulates the secretions, and tends to quiet nervous irritation. It has been a routine custom to give alcoholic stimulants in septic infections, but except when the vital functions need stimulating, this practice is falling into disuse.

Another well-established therapeutic procedure is, where anatomically possible, to remove the infection by a surgical operation. If the infected part is no longer functional, this can be done by an excision—as the surgeon removes an inflamed appendix, and a dentist removes a tooth whose utility cannot be reëstablished. In the presence of certain virulent infections, even more important organs may be sacrificed. The tongue or the cervical lymph nodes may be removed on account of a tuberculous infection, and an arm may be removed on account of a pus, gas bacillus, or other virulent infection that threatens life. A carbuncle may be totally excised. However, in many of our surgical operations for infection we are content with a less radical measure, which consists in draining the affected tissues by making one or several incisions. The tissue fluids are allowed to flow out of the wound, and with them great quantities

of the infecting organisms and their toxins. This free drainage often gives the fighting tissues just the help they need, and enables them to overcome the infection that remains.

There are three therapeutic agencies, all of established value, and each contradictory to one of the others, which have to be mentioned, but the rationale of which we do not fully understand. These are heat, cold, and passive hyperemia. One of the oldest treatments for localized infection is heat. In general, it seems to promote comfort, allay pain, and promote the circulation. With septic infections it probably predisposes to suppuration, but in the presence of a septic infection of a certain virulency, local suppuration cannot be regarded as an evil. Local irritants—counterirritants as they are sometimes called—act like heat, as they cause a deep as well as superficial dilatation of the blood vessels, with increased circulation. According to our ideas, an increased blood supply means increased resistance.

According to our present ideas, it is rather difficult to explain the good that undoubtedly results in many instances from the application of cold to an inflamed part. It cannot be from the direct action of the cold on the infecting organisms, for they are generally much too deep in the tissues to be influenced by a direct cooling effect. Cold, undoubtedly, causes a contraction of the blood vessels, a lessening of the inflammatory reaction, and tends to prevent suppuration and allay pain. Bier's hyperemia consists in the establishment of a temporary venous stasis, either by suction or by constricting the veins above the inflamed part. This is an augmentation of an essential part of the inflammatory process.

Finally, the organism may be aided in its fight by the introduction of specific antibodies against the particular infection in the form of serum and vaccines.

## SUBACUTE AND CHRONIC INFLAMMATION

The terms acute, subacute, and chronic may refer either to the duration of the process or to the strength of the irritant. In *acute* inflammation we have a rapid process of short duration. *Subacute* inflammation lies between the acute and chronic forms. In *chronic* inflammation we have a slowly progressive process with slight reaction on the part of the tissues, due to a weak toxic agent, such as the tubercle bacillus, or the treponema of syphilis, or the ordinary pyogenic organisms of low virulence. These chronic inflamma-

tory processes are usually characterized by an overgrowth of connective tissue. In bone there is frequently seen an excessive deposit of lime salts.

## SUPPURATION AND ABSCESS

Suppuration is one of the results of inflammation where the resistance of the tissues is overcome by the action of the microorganisms and their toxins and death and molecular destruction of the tissue cells and leucocytes takes place, with the formation of pus.

**Pus** is a yellowish fluid containing broken-down leucocytes (pus cells) and tissue cells, fat globules, albuminous granules, and bacteria and their products.

**Pus Producing Bacteria.**—The ordinary microorganisms responsible for suppurative processes are the so-called pyogenic cocci. These include the ordinary staphylococci, particularly aureus and albus, and the streptococcus pyogenes. Other organisms which frequently cause pus formation are the pneumococcus, the gonococcus, the bacillus coli communis, and the bacillus pyocyaneus. Less commonly are found the typhoid bacillus, the diphtheria bacillus, and others.

*Staphylococcus aureus* is the cause of the majority of cases of suppuration, being present almost everywhere that microorganisms are found. It is especially liable to be the cause of circumscribed suppurations, such as boils, localized abscesses, etc.

*Staphylococcus albus* is present normally in the skin, and is found in suppurative lesions of the skin, such as acne. This organism is responsible for stitch abscesses after operations.

*Streptococcus pyogenes* is the commonest cause of spreading infections, such as cellulitis, erysipelas, etc. It is more liable to cause systemic disturbance than the staphylococcus, infection with the streptococcus often resulting in grave septicemia. In streptococcus infection the tendency toward liquefaction of tissues and formation of pus is less than in staphylococcus infection, and although its presence is accompanied by violent inflammation, at most an imperfect watery pus is produced. When marked suppuration appears, it is more apt to be due to a combination with staphylococci.

**Tissue Changes in Suppuration.**—The phenomena of inflammation leading up to suppuration have already been described. During pus formation, where the staphylococcus is the invading organism,

the leucocytes form a barrier around the focus of infection—formerly erroneously called the pyogenic membrane or pus sac—which tends to limit its extent and thus form a localized **abscess**. In the presence of the streptococcus this leucocytic barrier is frequently not formed, and we have a spreading inflammation, or **cellulitis.** In either case the pressure of the inflammatory exudate and increased number of cells lessen the blood supply. The cells of the part undergo liquefaction by the action of proteolytic enzymes set free by the action of bacteria on leucocytes, and thus pus is formed. If the resisting powers of the body become strong enough to overcome the bacteria, the pus formation is checked, and repair begins. Where only a small amount of pus has formed, the fluid portion is absorbed by the lymphatics, while the disintegrated portions of cells and dead bacteria are removed by phagocytes. Where a large collection of pus has formed it may make its way to the surface following the path of least resistance and be discharged.

An **abscess** is a circumscribed collection of pus in a newly-formed cavity, as distinguished from **empyema**, in which the pus is contained in one of the natural body cavities such as the pleural cavity or the antrum of Highmore. The pus in an abscess tends to travel in the direction of least resistance, and hence generally approaches the surface of the body. The skin over the abscess becomes thinned and then bulges out more or less (pointing). Most abscesses are due to the staphylococcus, though other pyogenic organisms may be responsible. The bacteria may gain direct entrance to the part affected through a wound, or indirectly from other parts of the body through the blood or lymph streams (metastatic abscess).

**Symptoms and Diagnosis.**—The symptoms of abscess are local and general. *Superficial* abscesses are preceded by the signs and symptoms of inflammation, which often subside somewhat when free pus is formed. The *local* signs vary with the extent of the process and the nature of the tissues involved. In addition to the classical symptoms of inflammation, viz., heat, pain, redness, swelling and disturbance of function, the pain becomes *throbbing* or pulsating with the heart beat. *Edema,* or pitting on pressure of the skin may be noted due to the exudation of serum into the cellular tissues. *Pointing,* or a spot of softening as the pus approaches the surface, and *fluctuation,* or sense of the presence of fluid when two fingers are alternately pressed on either side of the

swelling, are two frequent signs. Occasionally, it is hard to say whether pus is present or not owing to excessive infiltration of the tissues, and incision alone will determine this point. The *general* symptoms of pus formation are fever, increased pulse rate, chills and sweats, general malaise, and *leucocytosis* or increase in the polymorphonuclear leucocytes in the circulating blood from 7500 to 15000 or more per cubic millimeter. *Deep seated abscesses* may be lacking in the ordinary symptoms, and sometimes present great difficulties in diagnosis. Edema of the skin is at times a good indication of the presence of pus beneath, when combined with the general symptoms of suppuration, such as chills, fever, etc.

**Treatment.**—The two cardinal principles to be observed in the treatment of abscess are *incision* and *drainage.* Pus formation and pointing may be hastened and the patient rendered more comfortable by the application of hot moist fomentations. The old-fashioned flaxseed poultice is more or less objectionable, and an efficient substitute is found in gauze pads soaked in hot weak bichloride of mercury solution and wrung almost dry. The heat and moisture may be retained to a certain extent by covering the gauze with oiled silk and applying a hot water bag outside this. In threatened abscesses about the face arising from diseased teeth it is undesirable to do anything that will favor pointing externally, and therefore as a general rule hot external applications should be avoided in these cases, although if the pus cannot be got rid of in any other way, cosmetic considerations must give way to regard for the safety of the patient. An incision should be made as soon as possible after the presence of pus is reasonably certain, and should be large enough to thoroughly evacuate the pus. It should be made if possible at the most dependent portion of the abscess, so that gravity will aid in drainage. Disfigurement is minimized by cutting in the direction of the muscle fibers covering the region rather than cutting across them. In this way the wound edges do not gape so much and a smaller scar will result. A point should be selected if possible in a natural fold of the skin, or in shadow where the scar will be least noticeable. In opening deep abscesses, where important structures, such as vessels and nerves, are to be avoided, the method advocated many years ago by Mr. Hilton should be used. This consists in making a small superficial cut only with the knife then separating the deeper tissues with a blunt instrument such as a grooved director until the pus is reached, and finally enlarging the opening from with-

in outward by means of a pair of hemostatic forceps inserted closed, separating their beaks, and withdrawing them open. Squeezing the abscess after incision should be avoided as it may break down the leucocytic barrier and cause the pus to invade fresh tissue. After the opening of large abscesses irrigation is often of advantage in evacuation of the pus. For this purpose warm saturated solution of boric acid or normal saline solution is useful and better than strong germicidal solutions, as the former does not destroy the vitality of the tissue. For *drainage* rubber tubing is preferable to gauze, as the latter soon becomes clogged and acts as a plug rather than a drain. Strips of rubber dam are used for drainage in small incisions.

*Dressing.*—The wound is to be covered with dry or moist gauze according to the condition of the part. Where considerable inflammatory reaction is still present, in the form of redness and inflammation hot moist dressings will be found more comfortable and promote absorption better than dry. The moist dressing also favors drainage. Here again, strong antiseptics are of no advantage, and may be harmful by irritating the skin. The Carrel-Dakin method of treatment is very suitable for some cases (see page 119).

## CELLULITIS

Cellulitis or spreading inflammation is usually due to streptococcus infection, although the staphylococcus is frequently present also, especially after suppuration sets in. Other organisms, such as the colon bacillus and the bacillus aerogenes capsulatus may also be responsible, forming gas bubbles in the tissue, giving rise to fine *crepitation* or crackling sensation (emphysema).

**Symptoms.**—The general symptoms are those of suppuration. The local symptoms of diffuse cellulitis are spreading redness and edema of the skin over a considerable area, which may be followed by fluctuation when free pus is formed. The inflamed lymph channels leading from the part may appear as red streaks under the skin (lymphangitis).

**Treatment.**—Cellulitis can often be prevented by early aseptic and antiseptic treatment of wounds, allowing for thorough drainage of all wounds in which it is likely infection can develop. When cellulitis has begun the process can often be controlled by hot moist applications, or by dressings of gauze saturated in

alcohol and covered with oiled silk. In more severe cases free opening and drainage with rubber tubing are indicated, moist dressings being afterward applied to prevent drying of the discharges. Dakin-Carrel treatment gives good results when properly used. General stimulating and eliminative treatment is often essential.

## SURGICAL FEVER

Surgical fever is a generalized infection occurring after injury or operation, due to the absorption of poisonous substances from the wound.

The term **aseptic surgical fever**, first described by Billroth, is applied to a temporary elevation of temperature frequently following a surgical operation or severe injury, not due to infection but believed to be caused by the absorption of fibrin ferment from the seat of injury. There is no evidence of infection in the wound and the patient feels well. There is a rise of temperature, sometimes to 103° F., beginning in the evening of operation or injury, and lasting for 24 or 48 hours.

Aseptic surgical fever requires no treatment. The symptoms of infection in the wound should be carefully watched for, and the bowels opened with a purge.

**Septic Surgical Fever.**—Under this general heading are included three conditions due to the dissemination of bacteria and the products of infection through the blood stream.

1. **Sapremia** is a constitutional disorder due to chemical poisoning by the products of saprophytic bacteria, these products having been absorbed from the wound. It is usually the result of putrefaction of a mass of dead material in a wound, such as a blood clot or decomposing organic material on a dressing.

The *symptoms* usually come on suddenly and early in the case. The temperature may rise to 103° or 104°, and is sometimes associated with a chill. The skin is flushed, hot and dry, and the patient complains of headache and thirst. The tongue is coated and vomiting may occur. The pulse is rapid and full, and the respirations increase in rate. Examination of the wound reveals a foul-smelling discharge.

The *diagnosis* from the next form of surgical fever—septicemia—depends chiefly on rapid recovery after removal of the putrefying material.

The *prognosis* is very favorable if the cause is removed early.

*Treatment.*—Clean out the putrefying blood clot or other material, taking care to injure the surrounding parts as little as possible. Do not use strong germicidal solutions. In severe cases stimulation may be advisable in the form of strychnine hypodermically. Subcutaneous infusion of normal saline solution, half a pint every three hours, dilutes the poison in the blood. Persistent vomiting is best treated by washing out the stomach. The diet, while marked symptoms persist, should be liquid, in the form of milk or albumin water.

2. **Septicemia** is a disorder caused by the action of living microorganisms that have gained entrance into the body and are undergoing growth and multiplication there. It differs from sapremia in that the poison is being continually produced within the body, while in sapremia the saprophytic organisms are acting on dead material in the wound and as soon as this dead material is removed the bacteria have no longer any pabulum on which to grow. The organisms usually associated with septicemia are the pyogenic cocci, which are absorbed from the wound into the surrounding tissues and into the blood stream, where they grow and liberate their toxins.

*Symptoms.*—As in sapremia, symptoms come on early. There is a rapid rise of temperature to 103° or 105°, which remains high and is usually associated with chills. The pulse is rapid, and in severe cases may be weak and irregular. Respiration is rapid and there may be dyspnea and cyanosis. Headache, and later, delirium, are usully present Examination of the blood shows leucocytosis. Locally, the tissues surrounding the wound (which may be a very small one) become swollen, reddened and tender, showing the signs of inflammation and later there may be suppuration. The neighboring lymph nodes are enlarged and tender and may suppurate.

The *prognosis* is grave. The disease is often fatal and recovery is generally very slow.

*Treatment.*—The wound should be thoroughly cleaned out. The same general treatment is indicated as in sapremia, but must be given more vigorously and continued for a longer time. Blood cultures may reveal the nature of the infecting microorganism in which case antitoxins may be administered.

3. **Pyemia** is a general septic condition produced by infection carried from a wound to distant parts of the body by means of small infected blood clots—septic emboli floating in the blood stream. When such a clot lodges in a capillary, a new focus of infection may occur. At first this is most likely to happen in the capillaries of

the lungs or liver. Ultimately a pyemia may cause numerous localized infections in many parts of the body with the production of metastatic abscesses. A case of osteomyelitis of the mandible, for instance, may be followed by pyemia, with secondary foci in the lungs, peritoneum and joints.

*Symptoms.*—Pyemia does not, as a rule, begin so early as either of the other two forms of surgical fever. Local signs of inflammation appear in the wound. The general symptoms begin with a chill and rapid rise of the temperature to 104° or 105°. This is followed by profuse sweating and a fall of the temperature two or three degrees. Chills, fever, and sweats occur irregularly throughout the course of the disease. The other symptoms resemble those of septicemia, but are more severe. The secondary abscesses appear from the sixth to the tenth day, and may be located in the lungs, spleen, kidneys, brain, peritoneum, muscles and joints, giving rise to special symptoms according to the organ affected.

*Prognosis.*—Pyemia is extremely fatal, particularly when vital internal organs are involved in the secondary abscess formation.

*Treatment.*—The wound or primary seat of infection must be thoroughly cleaned and drained. Cold sponging may control the fever. The patient should be stimulated as in septicemia. Morphine may be required to relieve pain. Secondary abscesses, if accessible, must be opened and drained.

## ULCER AND ULCERATION

Ulcer is the defect that remains after a local surface destruction of tissue from bacterial invasion, from the breaking down of a tumor, or following a number of different inflammatory processes the cause of which we may not understand. Any open sore, whether it be the result of the bursting of a herpetic blister; the breaking down of a carcinoma, of a gumma, or a tubercle; whether it be the granulating surface left after the separation of a superficial slough; an open sore due to the melting away of any of the surface tissues; or an open sore of almost any kind, excepting the acute stages following an injury—any of these may be spoken of as an ulcer. Naturally the varieties of ulcer are very numerous.

## GANGRENE

Gangrene is necrosis or death en masse of soft tissue. A mass of gangrenous tissue is sometimes spoken of as a *slough.*

**Causes.**—Gangrene may be due to causes that result in immediate death of the tissues such as bacterial and other chemical poisons, direct physical injury, extremes of heat and cold, or to causes acting *indirectly* through stoppage of the circulation. Thus, the circulation to a part may be interfered with by (a) mechanical injury to the blood vessels such as bruises, crushes, gunshot wounds, ligatures, pressure of bandages, etc., (b) diseases of blood vessels, such as arteriosclerosis, thrombosis and embolism.

**Varieties of Gangrene.**—When the arterial supply is gradually shut off, we have produced what is known as *dry gangrene,* characterized by a shrivelling up of the part affected, which turns black and finally drops off if not removed by the surgeon. In *moist or acute gangrene* there is a sudden stoppage of the circulation, the tissue fluids being unable to escape by means of the veins and lymphatics. The part becomes swollen by distention of the tissues with exudation from the vessels, putrefaction sets in, giving rise to a foul odor. The skin is cold, the pulse cannot be felt in the part, and sensation is absent.

Gangrenous processes, if allowed to continue, eventually limit themselves from the healthy tissues, by forming a *line of demarkation.* Absorption of the products of putrefaction or secondary infection, often causes grave systemic complications.

The **treatment** of gangrene may be briefly stated to consist in removal of the gangrenous tissue as soon as a line of demarkation has formed, and proper care of the resultant granulating wound. Septicemia will also require appropriate systemic treatment.

## NECROSIS

Literally, the term necrosis means death *en masse* of any tissue, but is usually applied to death of bone. It is produced in the same way as gangrene of the soft tissues, by any agent that destroys its blood supply, either through the internal portion of the bone or the periosteum covering the bone. It may thus follow trauma, chemical action (as seen in poisoning of various kinds,—phosphorus, arsenic, etc.), and microbic invasion of the bone marrow (osteomyelitis), or of the periosteum (periostitis). Bones are nourished through blood vessels carried through the marrow or the periosteum, so that necrosis is essentially the result of starvation from interference with either of these sources by inflammation or injury, or by derangement of the trophic nerves, which govern the nutrition of the bone.

When necrosis occurs, the dead bone eventually becomes separated in the form of a *sequestrum.* Around the sequestrum, particularly if the periosteum has not been destroyed, there is frequently formed a shell of new bone, known as the *involucrum.* Between the sequestrum and the involucrum the inflammatory process goes on, forming pus, which makes its escape through openings on the surface of the bone known as *cloacae.*

(For symptoms and treatment see osteomyelitis and necrosis of the jawbone, page 244.)

## SINUS AND FISTULA

Sinus and fistula are terms often used interchangeably, though strictly speaking, each has its own correct application.

A *sinus* is a communicating tract in the tissues, lined with granulations, between a suppurating area and the surface of the body.

A *fistula* is a pathologic communication of a normal epithelial-lined cavity or secreting organ with the body surface, or between two epithelial-lined viscera, through which the modified secretion or normal contents of the cavity pass.

**Sinus.**—*Causes.*—Sinus may be the result of (1) an abscess with too narrow an opening, resulting in imperfect drainage and persistence of the discharge; (2) presence of a foreign body, dead bone, teeth or other tissue, bullets, unabsorbed ligatures, etc.

*Diagnosis.*—A sinus presents a narrow opening on the skin or mucous membrane surface through which pus discharges. Very often an excess of granulation tissue presents at the orifice, forming a sort of papilla. Usually a probe can be passed into the sinus for some distance and may encounter dead bone or a foreign body.

*Treatment.*—Removal of the cause, such as foreign bodies, dead bone, teeth, etc., is the first consideration. This is usually done by thoroughly opening the sinus tract. If this does not suffice, it may be necessary to excise the walls of the sinus or curette them thoroughly, followed by cauterization with silver nitrate, and packing with iodoform gauze to promote healing by granulation from the bottom of the wound. The injection of bismuth paste often proves successful, distending the tract, and keeping the walls apart as healing takes place from the bottom, at the same time permitting drainage.

**Fistula.**—*Causes.*—(1) Fistula may be congenital, e. g., branchial fistula from failure of one of the branchial clefs of the neck to close; (2) trauma, severing the natural duct of a gland, and producing an

abnormal opening. Salivary fistula may be produced in this way. (3) Infection may result in obstruction of the natural duct of a gland, followed by spontaneous or operative evacuation of pus in an abnormal place, resulting in a fistula.

*Diagnosis.*—The principal point in diagnosis of fistula is the presence of an abnormal opening on the skin or mucous membrane, from which a discharge of the secretion of the particular gland involved can be recognized. In cases complicated with much suppuration it may be at first difficult to determine the presence of fistula, until the discharge becomes free from pus.

*Treatment.*—The obstruction to the natural duct of the gland should be removed if possible, and any complicating conditions, such as infection, etc., treated. Physiological rest is important. Closure of the fistula sometimes requires a plastic operation.

## REPAIR OF TISSUE

Repair or healing is the process by which tissue returns to normal or as nearly normal as possible after injury. This process is very closely associated with inflammation and it is difficult to say at what point inflammation stops and repair begins.

Repair may be favored or retarded by both local and general conditions. Among *general* conditions which retard the process of repair may be mentioned diabetes, anemia, tuberculosis and starvation. *Local* conditions hindering repair are free mobility of the injured part, tight dressings interfering with the circulation, cold, infection, and the use of strong antiseptics; repair is favored by rest, warmth, absence of infection.

The process of repair may be simple or complex, according to the number and variety of the cells injured or destroyed, the quantity of blood poured out, and the presence or absence of bacteria or other complicating injurious agents. The difference in different cases is chiefly a matter of degree, according to the amount of tissue lost.

**Healing by primary union or first intention** occurs in the case of simple incised wounds, in which few tissue cells have been destroyed, where the edges of the wound have been brought into apposition, and where the surrounding parts are uninjured either mechanically or by bacterial invasion. Following the incision there is more or less exudation of serum and leucocytes. At the same time there is proliferation of the fixed connective tissue cells of the part. These young connective tissue cells are known as *fibroblasts,* and are the

principal agents in replacing the lost tissues. They extend across the wound, binding its edges together, and eventually develop into white fibrous tissue. From the walls of the neighboring capillaries, plugs of endothelial cells are thrown out, which unite with similar outgrowths from the opposite side of the wound. These plugs are at first solid, but later become hollowed out, forming new blood channels. The surface epithelium is replaced by new cells extending from the sides of the wound.

**Healing by second intention** or by granulation, is the process of repair that takes place where there has been considerable loss of tissue or where the edges of a wound are separated. The essential changes that take place are the same as in primary healing except that they are more extensive. There is proliferation of fibroblasts and vascular endothelium to form the new connective tissue which replaces the lost tissue. This newly formed tissue is known clinically as *granulation tissue* owing to its red granular appearance. Each granule represents a new capillary loop. Later, the granulation tissue becomes less vascular, contracts, and becomes *scar tissue.* The surface of the wound at the same time becomes gradually covered by proliferation of the epithelium.

**Repair of Bone.**—In the repair of bone we have practically the same process as in the repair of soft tissues plus a deposit of lime salts. After inflammation and necrosis of bone, repair is a slower process than after a simple fracture because the necrosed bone has to be disposed of.

The question as to the mode of growth and repair of bone has received a great deal of attention in late years. Until recently it was generally accepted that the new bone was produced chiefly by the periosteum and in part by the endosteum or inner lining of the bone. A few years ago, however, Macewen of Glasgow recorded the results of his experiments from which he concluded that the periosteum has nothing to do with bone production, that it is merely a limiting, protecting, and to some extent a nourishing, membrane, and that the new bone is formed by cells within the bone itself. He was able to bring about regeneration of considerable portions of bone after the periosteum had been entirely removed. Other observers agree in the main with Macewen's conclusions, but some claim that it is merely a question of interpretation of the experiments, as to whether the bone producing cells are to be regarded as within the periosteum or in the outer layer of the cortex of the bone itself.

As an illustration of the method of bone repair we will consider

what occurs after a simple fracture of a long bone, in which there has been little or no displacement, and the parts are kept at rest. At the time of the injury some hemorrhage occurs into the soft tissues about the fractured ends, followed by exudation of serum. Fibroblasts proliferate from the periosteum and endosteum into the space between the fractured ends of bone and also on the outside of the shaft and within the marrow cavity, forming a mass of new connective tissue. Cartilaginous trabeculae are now formed throughout this tissue by large bone cells known as *osteoblasts.* Lime salts are then deposited, forming new bone which joins the ends of the original bone, covering the fragments for some distance both on the outside of the shaft and within the marrow cavity. This new bone is known as the *callus.* The callus on the outside of the bone is sometimes called the periosteal callus, that on the inner surface or in the narrow cavity is known as the myelogenous callus, while the new tissue which lies between the ends of the fragments is commonly designated the intermediary callus. A good deal more callus is formed at the seat of fracture than is required to restore the bone to its normal condition, and after a time certain giant cells called *osteoclasts* begin to remove the excess of callus, re-establishing the continuity of the marrow cavity between the two fragments and dissolving the excessive bone formation on the outside of the shaft. Finally, the bone is restored to approximately its normal shape and size.

The repair of bone is sometimes complicated by extensive hemorrhage, necrosis, wide separation of fragments, interposition of fibrous and muscular tissue, infection, undue mobility, etc.

**Repair of Bone after Necrosis.**—Repair under these circumstances is considerably delayed owing to the presence of the necrotic bone, as the latter has to be removed. In time, however, the necrotic bone is separated from the living bone through the action of the osteoclasts, and forms what is known as a *sequestrum.* This sequestrum may be gradually dissolved or may be thrown off spontaneously or removed surgically. During the process of elimination of the sequestrum, new connective tissue is formed around it, from which callus is developed, resulting in thickening, and a shell of new bone, called the *involucrum.* After the sequestrum is thrown off the space is filled in with new bone. In the mandible, an entire new bone may be formed after necrosis.

## CHAPTER IV

## SPECIAL INFECTIONS: SYPHILIS, TUBERCULOSIS, ACTINOMYCOSIS, ANTHRAX, TETANUS

### SYPHILIS

It is very important that the dentist should have some knowledge of syphilis, because many of its most characteristic and contagious lesions occur in the mouth, and it is not infrequent that through these lesions the disease is transmitted to innocent persons. There are also many ulcerations and forms of disease in the mouth due to other causes, that might easily be mistaken for syphilis, if one has not a general knowledge of the latter and the means employed for diagnosing it. There is sometimes a little hesitancy on the part of the dentist about caring for the teeth of syphilities, for which there is no excuse, if one has a knowledge of the precautions necessary to avoid contagion. A knowledge that a patient has syphilis should be sufficient safeguard against transmitting it to others. Syphilis is no more contagious than many other diseases regarded with much less repugnance, and its virus is just as easily destroyed by sterilization. Instruments properly sterilized by boiling are just as clean after treatment of a syphilitic as after any other case.

The origin of syphilis, or lues, as it is sometimes called, is lost in obscurity. In the Bible are described various plagues, some of the symptoms of which correspond more or less closely to syphilis, but which cannot positively be linked with that disease. Indeed many writers deny that syphilis existed in Biblical times. The earliest period at which we can with certainty identify its presence in Europe is the end of the fifteenth century. At this time it swept over the continent in a great epidemic. The severity of this outbreak is good evidence that lues was then a new disease in Europe. There is some little foundation for the belief that syphilis was introduced into Europe from America by the sailors of Christopher Columbus. From the acute and severe type existing during the outbreak in the fifteenth and sixteenth centuries, syphilis has gradually settled down to the comparatively mild form usually seen at the present time. Occasionally we see a malignant and sometimes

rapidly fatal case. Syphilis is to be regarded as an eruptive fever, just as are measles, smallpox and scarlet fever, differing from these in that it runs a course of months or years rather than days. In the last twenty years three notable advances have been made in our knowledge of the etiology, diagnosis and treatment of syphilis. In 1905 Schaudinn announced his discovery of the Spirocheta pallida or Treponema pallidum, the organism causing the disease. A year later Wassermann published his method of serum diagnosis by the complement-fixation method of Bordet and Gengou, and in 1910 Ehrlich brought out salvarsan, or arsphenamine, an arsenical preparation, the most effective remedy so far discovered for the treatment of syphilis.

**Etiology.**—The cause of syphilis is the Spirocheta pallida or Treponema pallidum, a pale, delicate organism, spiral in form, from 4 to 15 microns in length, with from 10 to 20 turns. These twists are close together and are regular as to length and breadth. The organism is motile, having both a side to side motion and a twisting on its long axis. The spirochete may be found in all of the lesions of syphilis, but is best studied in preparations made from the primary sore or chancre, and from mucous patches. Special methods must be employed for demonstrating the organism, the best being microscopic examination of a wet preparation by dark-field illumination, by which the movements can be studied. The organism stains with great difficulty. Noguchi has succeeded in cultivating the spirochete and inoculating animals with it, producing syphilitic lesions in them.

**Mode of Entrance.**—Infection with the Spirocheta pallida is transmitted through some break in the skin or mucous membrane. Mere contact with the unbroken surface of the body is not sufficient. The usual mode of infection is through sexual intercourse with a person having syphilitic lesions of the genitals. Consequently, the most common site of the primary infection is the genital organs. The disease may also be acquired, however, in an entirely innocent manner, through infected drinking cups, eating utensils, razors, kissing, etc. A surgeon or a dentist may become infected through a wound of the hand coming in contact with a syphilitic lesion. The disease may be transmitted through surgical or dental instruments in the hands of operators who are negligent about sterilization. Finally syphilis may be inherited by a child from either parent.

Syphilis is broadly divided into three stages, primary, secondary

and tertiary. The last two may merge into one another more or less, without a sharp line of demarcation.

**Primary Stage.**—The primary lesion of syphilis is known as the *chancre*, which always appears at the point at which the infection enters the body, and nowhere else. It is therefore nearly always a single lesion, though more than one sore may be present on two surfaces in close contact, or where there has been more than one abrasion of the surface. The usual situation of the chancre in the male is on the glans penis or the prepuce, though in cases of extra-genital infection it may be on the lip, tongue, tonsil, nipple, finger or other part of the body. Schamberg reports eight cases of chancre of the lip as the result of infection from a single person transmitted by kissing games at a party. The chancre may assume many forms, but only the typical or Hunterian sore will be described. It first makes its appearance about three weeks after exposure. It begins as a small, slightly raised papule, which slowly grows larger, and finally breaks down, forming an ulcer. This ulcer is oval or round, about the size of a ten cent piece, with raised edges. Its most distinguishing feature is its hard base, giving the feeling almost of cartilage. The chancre is rarely painful. With its appearance, the neighboring lymph glands become enlarged. Thus, in the case of a chancre of the penis, the inguinal glands are swollen, while in the case of the lip or mouth, the submaxillary lymph glands are affected. The enlargement is polyganglionic, that is, several distinct hard nodes are felt, which do not coalesce, and do not suppurate. The enlarged glands are not, as a rule, painful or tender unless there is a mixed infection by other organisms. The chancre may heal rapidly in a few weeks, or it may persist for months. When it heals it usually leaves an indurated scar that can be seen for many years.

**Secondary Stage.**—About three to seven weeks after the appearance of the chancre the secondary symptoms begin to appear. There is a general *adenopathy,* or painless lymphatic glandular enlargement, more particularly felt in the epitrochlear and posterior cervical regions. In addition, there is slight fever, headache, general joint pains, shedding of the hair, sore throat, and anemia. The most characteristic secondary lesion, however, is the *rash,* which may assume many forms. In the most typical cases it begins as a roseola, or slight reddening of the skin, which gradually develops into small distinct spots or macules. This eruption is found on the face, back, chest, and particularly the flexor surfaces of the

extremities. From macular, the rash progressively becomes slightly raised or papular, then pustular, and sometimes ulcerative. Examples of these different lesions may all be found at the same time. They occur symmetrically on the two sides of the body, vary only slightly in size, from that of a split pea to a pinhead, and itch but little if at all. The eruption is not bright red in color, but has a dull brick-red shade. *Mucous patches* are papules and pustules occurring on moist skin surfaces or on mucous membranes. They are found on the genitals, about the anus, under the breasts, and on the mucous membrane of the mouth. Their favorite locations in the mouth are the tonsils, the uvula and soft palate, the sides of the tongue, and the inner surfaces of the lips. Mucous patches are oval, slightly raised, grayish white, and moist, and leave a raw bleeding surface when scraped off. They are probably the most contagious lesions of syphilis and their common occurrence in the mouth makes them extremely important to the mouth specialist. The sore throat and hoarseness of this stage are caused by mucous patches in the pharynx and larynx. There may be a general inflammation of the gums or gingivitis. In the late secondary stage deeper tissues become involved, and we note pains in the bones and joints, and larger eruptions involving the deeper layers of the skin. Affections of special organs are frequently seen in secondary syphilis, for example, iritis, otitis media, etc. The chief symptoms of the secondary stage, then, are, the symmetrical skin eruption consisting of small lesions, enlargement of the epitrochlear and posterior cervical lymph nodes, mucous patches, sore throat, and falling out of the hair.

After the secondary stage, if the case has been sufficiently treated, no further symptoms may appear. Otherwise there may be an intermediate period of 18 months to 3 years that may be free of symptoms. These symptomless periods in the course of syphilis may also occur at any time and are known as *latent periods.* If further symptoms appear, we enter the tertiary stage.

In the **tertiary stage** practically any tissue or organ of the body may be involved. In the skin we see deep seated ulcers known as *rupia.* These are large punched-out sores which vary in size and occur asymmetrically, thus differing from the secondary lesions. On healing, they leave ugly, pigmented scars, giving the characteristic copper-colored spots. In the internal organs of the body and deep tissues the typical tertiary lesion is known as the *gumma.* This starts as a localized painless swelling, which slowly softens

and breaks down, sometimes reaching the surface of the body and discharging a dirty brownish fluid. The slow growth often causes the differential diagnosis of gummata from tumors to be difficult. A gumma may be found in the muscles and bones, the liver and other abdominal organs, the brain, tongue, larynx and soft palate. In addition to these circumscribed lesions, the tertiary stage of syphilis may manifest itself in a more diffuse way, such as osteo-periostitis, glossitis, etc.

**Mouth manifestations** of the various stages of syphilis are of special interest to the dentist and oral surgeon. The *chancre* or primary lesion, may be situated on the lip, the tongue, the palate, or the tonsil. If the chancre is in any of these locations, there will be at the same time an enlargement of the lymph glands of the submaxillary region. In the *secondary* stage *mucous patches* are often found on the tonsil, uvula, soft palate, the inner surfaces of the lips, the sides of the tongue, and there may be a generalized gingivitis.

In the *tertiary* stage there may be osteoperiostitis of the jawbones particularly the upper jaw, palate, ethmoid, and nasal bones. This may be characterized by recession of the gums, loosening of the teeth, followed by necrosis. When the hard palate is involved, a painless swelling first appears; this softens and breaks down, exposing the bone, which may be thrown off as a sequestrum, causing a perforation in the palate, and in extensive cases converting the mouth and nose into a common cavity. The septum and nasal bones are sometimes lost, causing the characteristic "saddle-nose" deformity. The lower jawbone is more rarely involved. A gumma may develop in the tongue, or the latter may be the seat of a more diffuse inflammation, known as sclerosis, in which the organ becomes pale, and the mucous membrane greatly thickened and irregular, being traversed in some cases by deep fissures.

**Inherited Syphilis.**—In this form, the child receiving the infection during its development *in utero*, there is, of course, no primary lesion or chancre. The secondary and tertiary symptoms are the same in a general way as those of acquired syphilis, though a few special signs are to be noted. Symptoms usually appear within three weeks after birth. Those most commonly seen are snuffles and hoarseness of the voice, skin eruptions, enlargement of the liver, iritis and interstitial keratitis, and malnutrition. Later, in addition to these, are noted flat nose, coryza, opacities of the cornea, ulcerations of the palate "sabre deformity" of the tibia, fissure-like

scars radiating from the corners of the mouth and nose (rhagades), deafness, and deformities of the teeth. *Hutchinson's teeth,* regarded as characteristic of inherited syphilis, are seen typically in the upper permanent central incisors, though other teeth may also present evidences of poor development. The central incisor is barrel-shaped, with an erosion of the enamel at the cutting edge, forming a crescentic notch.

Under the heading of *late syphilitic lesions* are classified certain diseases of the blood vessels, particularly aortitis and aneurysm, and also two diseases of the nervous system, viz.: locomotor ataxia or tabes dorsalis, and general paresis.

**Diagnosis of Syphilis.**—In the *primary stage* of syphilis clinical diagnosis is often very difficult, and it was formerly the practice to always wait for the appearance of the secondary symptoms by withholding treatment in order to be sure of the diagnosis. The following points are important in establishing the diagnosis of chancre: (1) A period of three weeks or more after exposure to venereal infection before the appearance of the lesion. (2) A painless lesion with an indurated base. (3) Painless, polyganglionic enlargement of neighboring lymph nodes. These points may serve to distinguish a chancre from other ulcerations, which usually appear within a few days after abrasions of the surface, are not so indurated, and the mixed infection from which causes painful and conglomerate enlargement of the lymph nodes. In the majority of cases, the finding of the Spirocheta pallida in wet preparations made from the sore and examined microscopically by *dark-field illumination* renders it possible to make a certain diagnosis very early, without waiting for secondary symptoms. This examination should always be made where primary syphilis is suspected. The *Wassermann reaction* also frequently becomes positive before appearance of the rash, but a negative Wassermann does not exclude chancre. A chancre of the lip may be taken for epithelioma, but the latter usually only occurs after middle age, is painful, grows slowly, and the lymph glands are not immediately involved. The finding of the Spirocheta pallida, the positive Wassermann reaction, and the appearance of secondary symptoms will confirm the diagnosis of chancre.

*Secondary Stage.*—In the presence of symptoms as previously described, together with the history of a primary lesion, which may still be present, and a positive Wassermann reaction, the diagnosis will be established beyond doubt. Mucous patches may be confused

with simple ulcers. The latter are rounded instead of oval, with reddish borders, are painful, and there are no other lesions of syphilis present.

*Tertiary Stage.*—The diagnosis of tertiary lesions is sometimes very difficult, as they may be found many years after occurrence of the primary infection, and patients are especially forgetful when questioned about venereal disease. A history of miscarriages or stillbirths is important in women. Necrosis of the hard palate is usually due to syphilis. Gumma of the tongue may run a course similar for some time to that of carcinoma, in fact, carcinoma may develop from a gumma or other syphilitic lesion. In both carcinoma and gumma there will be a lump, slowly increasing in size, which finally breaks down and presents an ulcerated surface. The gumma is usually painless, not very hard, there may be a history and other signs of syphilis, and the Wassermann reaction is generally positive. Cancer of the tongue is generally hard and painful, the neighboring lymph glands are sooner or later palpable, and the Wassermann reaction may be negative. A positive Wassermann reaction of course does not exclude the presence of cancer as well as syphilis.

*Laboratory methods in diagnosis of syphilis.*

In the primary stage the most valuable laboratory procedure is the microscopic detection of the Spirocheta pallida in wet preparations made from the lesion, by means of dark-field illumination.

The *Wassermann reaction* marks the greatest advance in recent years in the diagnosis of syphilis. This depends on the detection in the patient's blood of certain substances produced by the action of the syphilitic virus. These substances are detected by their ability to fix complement in combination with an extract made from syphilitic tissue or an artificial antigen. The Wassermann reaction becomes positive late in the primary stage of syphilis, that is, from the 10th to the 30th day after appearance of the sore, showing that some time is required for the appearance of the syphilitic antibodies in the blood. In the secondary stage of syphilis, the reaction is positive in practically 100 per cent of cases. In the tertiary stage it is positive in over 75 per cent of cases. During the latent periods of syphilis, in which no symptoms are manifest, the Wassermann reaction is positive in at least 50 per cent of cases. Treatment has a tendency to render the reaction negative, so that no treatment should have been given for at least three weeks before testing the blood in a given case.

There are one or two other diseases that sometimes give a posi-

tive Wassermann reaction but they are not liable to be confused with syphilis. The most important of these is leprosy. Scarlet fever and malaria have been reported as giving a positive reaction, but in these it is only temporary. As far as diseases common to this country are concerned, a positive Wassermann reaction may be regarded as peculiar to syphilis. A negative reaction does not necessarily exclude syphilis, unless repeated tests are made.

The *Luetin Reaction* is a specific cutaneous test for syphilis by the intradermic injection of an emulsion made from a culture of Spirocheta pallida. When positive a small erythematous area with induration appears at the site of injection and persists for several days. During the primary and secondary stages the reaction is infrequent, but according to Noguchi, it is positive in 94 per cent of late and in 96 per cent of latent cases. The luetin reaction may be of value in cases where the Wassermann reaction is negative.

**Treatment of Syphilis.**—Treatment should not be commenced until the diagnosis of the primary lesion is certain, but as soon as the diagnosis is made, treatment should be begun at once, because under these conditions the patient has the best chance for cure. Before being put on antisyphilitic treatment of any kind and especially mercury, every case should, if possible, be sent to the dentist to have the mouth and teeth put in the best possible condition. Tartar should be removed, cavities filled, and all useless and unhealthy teeth and roots extracted. The patient should diligently use a tooth-brush and mouth wash during the entire period of treatment. If these directions be carried out, mercurial stomatitis will rarely occur.

The modern treatment of syphilis includes the use of three drugs, arsphenamine and its allied compounds, mercury, and potassium iodide.

The intravenous administration of arsphenamine or salvarsan is the most effective means of causing the disappearance of the manifestations of syphilis. The usual dose of arsphenamine is 0.6 gm., properly neutralized and diluted with hot sterile water. It is customary to give several courses of treatment, each course consisting of from four to six injections at weekly intervals, followed by mercury by mouth or by inunctions. In early cases, before the Wassermann reaction becomes positive, one course may suffice to cure. If the Wassermann reaction is positive after one course of arsphenamine and mercury, even in the absence of symptoms, ananother course should be given after an interval of a few weeks.

After cessation of treatment the Wassermann reaction should be performed every three months or oftener for at least two years, and should be returned negative for this period before the patient may with safety be pronounced cured. As a rule, the later in the course of syphilis that treatment is begun, the more difficult it will be to effect a cure, as evidenced by disappearance of symptoms and permanently negative Wassermann reaction. If seen in the early stages we are justified in regarding syphilis as a curable disease. When mercury is given by mouth, the protiodide, one to three grains per day, is generally used. Mercurial ointment is used for skin inunctions, one dram being rubbed in daily. Several preparations of mercury are employed for hypodermic or intramuscular use. One of the best is the salicylate, made into a 10 per cent emulsion in oil. In late cases of syphilis, potassium iodide may be added to mercury. This is given in beginning doses of ten grains increased gradually to one dram three times a day in milk, after meals. Potassium iodide has no specific action on the syphilitic virus, but causes absorption of newly-formed connective tissue, and is therefore a valuable aid to the specific antisyphilitic drugs.

## TUBERCULOSIS

Tuberculosis is an infectious disease caused by the Bacillus tuberculosis.

**Etiology, and Portals of Entrance.**—The various modes by which the tubercle bacillus may gain entrance to the body are: (1) Inhalation. (2) Carious teeth and tonsils. (3) Digestive tract by means of food containing the bacilli. (4) Direct inoculation through breaks in the skin or mucous membrane surface. (5) Intrauterine infection through the placental circulation.

1. It has been thought for a long time that infection of the lungs by inhalation is the commonest mode of production of tuberculosis, but more recent observations are giving increased importance to the digestive tract as a source of infection.

2. The bacilli may gain entrance through carious teeth and diseased tonsils, thence infecting the cervical lymph nodes.

3 Intestinal tuberculosis occurs in about 30 per cent of all cases.

4. Direct inoculation through abrasions and wounds may occur.

5. While the tubercle bacillus can be transmitted from parent to offspring through the placental circulation, this is very rare.

Cases are frequent, however, where hereditary predisposition gives increased susceptibility to infection by the tubercle bacillus.

**Pathology.**—Miliary tubercles are small, grayish yellow or white nodules. In acute miliary tuberculosis they may be found in great numbers throughout the principal internal organs. Microscopically, in a typical tubercle, three zones are present: A central zone containing large giant cells, with many nuclei situated at the periphery of the cell; the giant cells are surrounded by a zone of spindle shaped epithelioid cells; a third outer zone consists largely of small round or lymphoid cells (Fig. 9). Inflammatory lesions

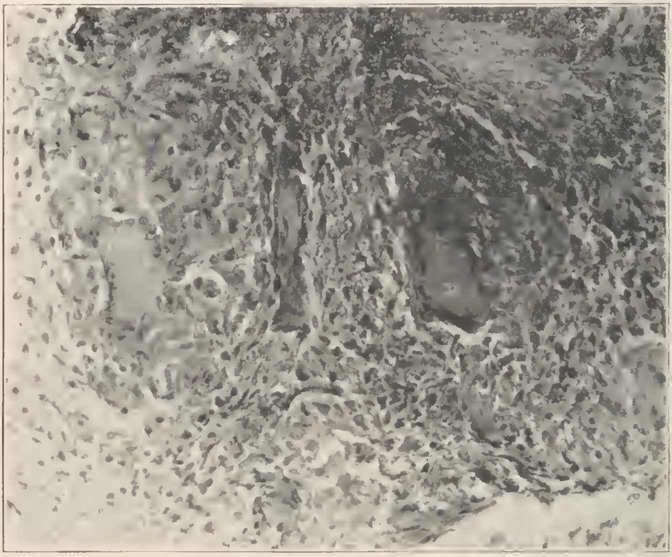


Fig. 9.—Tuberculous ulceration of mouth.

occur in the tissue between and surrounding tubercles. Caseous changes take place in the tissue, with the development of areas having a dull, opaque appearance. Liquefaction occurs in the necrotic caseous tissue, with resulting cavities. In tuberculosis of bone, cavities may be formed, filled with liquefied caseous material, and are known as cold abscesses. There is a tendency to encapsulation of tuberculous foci by the formation of fibrous tissue.

**Special Forms of Tuberculosis.**—Organs affected.—The lungs, pleura, lymph nodes, peritoneum, bones and joints are the commonest seats of the disease. From a surgical standpoint, the bones and joints, and the lymph nodes are the most important.

**Tuberculosis of Bone.**—The pathological changes that occur in bone in the course of this disease are much the same as in other parts. Through circulatory channels the bacilli become arrested in the bones, particularly in the epiphyses. Tuberculous foci are formed, causing bone destruction and absorption, caseous degeneration, cavity formation and sequestra. In comparison to the number of people whose mouths are exposed to infection from the lungs. tuberculosis of the jawbones is rather rare, and an infection at the epiphysis of the mandible extremely so. The sequestra in tuberculous osteomyelitis rarely completely separate.

**Tuberculosis of the Mucous Membrane of the Mouth and Tongue** occurs in several forms, but in all instances is caused by an infection with the tubercle bacillus. There are two varieties of tuberculosis of the soft tissues of the mouth which give a different appearance and clinically run very different courses. They are lupus and ordinary tuberculous inflammation. Lupus is characterized by the formation of groups of superficial tubercles and a tendency to scarring and contraction, and little aptitude for very active ulceration. Lupus of the face is usually present with lupus of the mouth. Ordinary tuberculosis of the mouth is usually secondary to pulmonary tuberculosis, but may be primary. After the first stages, ulceration is the most prominent characteristic. Tubercles first appear as small yellowish nodules from 1 to 5 millimeters in diameter, and in this stage are usually discovered by accident. They seldom attain large size without ulcerating. At first there are always one or more tubercles, but these may ulcerate so rapidly as to escape notice. The infection may occur in any part of the mouth, but it is peculiar that tuberculosis of the maxilla and roof of the mouth is not nearly so virulent as, and runs a milder course than, tuberculosis of the tongue, floor of the mouth or mandible. While early in their course these tuberculous lesions cause little or no inconvenience and are free from pain, in their later stages they are extremely painful and tender. When completely formed and not sloughing too extensively, a tuberculous ulcer shows an uneven pale flabby surface with granulations, or covered with a grayish yellow secretion. The edges may be slightly redder than the surrounding mucous membrane. They are usually sharp cut or beveled, rarely elevated, everted or undermined.

**Diagnosis.**—A provisional diagnosis of tuberculous lesions is to be made partly from their clinical characteristics and partly from serum reactions. An absolute diagnosis is obtained from the demon-

stration of the tubercle bacilli. Every patient suspected of tuberculosis of the mouth should be given a thorough physical examination. It is to be remembered that tuberculosis can arise in a syphilitic; a gumma, carcinoma, or any other lesion in a phthisic. It has been observed that gummata show a greater predilection for the dorsum of the tongue, while the tubercles are more apt to occur in the tip or edges; but this is only relative, and does not warrant conclusions in the individual case. The same is true of the fact that the tuberculous lesions early, carcinomata late, and gummata very rarely cause enlargement of the lymph nodes. The exceptions to these rules preclude them from being relied upon for final decision.

The von Pirquet and other reactions of the same character can be used only as contributory evidence; for after two years they are frequently present when there is no evidence of an active tuberculous lesion, and are sometimes absent during certain stages of an active tuberculosis. Koch's serum reaction is, we believe, more reliable. If one will adopt the rule of excising all isolated subacute or chronic lesions of unknown cause, then the preoperative diagnosis of tuberculous lesions of the mouth is not so important. If one hesitates to do this, then the scrapings of the tissue should be examined for tubercles, and if this is negative, an emulsion is to be injected into guinea pigs.

**Treatment.**—The local treatment of a tuberculous infection of the mouth will vary with the character of the lesion, its location, and the general condition of the patient. Lupus anywhere is to be treated with such milder measures as the Finsen light, curetting, the application of lactic acid, or the x-ray. Tuberculous nodules and small ulcers are to be excised, and the defect closed by immediate suture. In the roof of the mouth and upper jaw, larger ulcers may be scraped, and the surface repeatedly painted with lactic acid. On the tongue or the floor of the mouth or lower jaw, the ordinary tuberculous infection is in the majority of cases as fatal as cancer, and it should be treated accordingly. A possible exception to this may be made in patients with pulmonary or general tuberculosis, and such patients can be made much more comfortable. The general treatment should be the same as in any tuberculous infection, and one of the first things gained by excision is freedom from pain, rest, and ability to take food. Specific vaccines may be employed by those familiar with the methods. As

in cancer, the favorite treatment of tuberculosis at present is the use of actual cautery. Hygienic treatment should not be overlooked.

## ACTINOMYCOSIS

Actinomycosis is a chronic infective disease occurring in cattle, and rarely in man. It is due usually to the actinomyces bovis or ray fungus, but the same symptoms may be caused by other allied organisms.

The appearance of the lesion varies according to the part affected, and the presence or absence of pyogenic organisms. The head and neck are involved in more than half the cases. Frequent involvement of the maxillary region gives rise to the name "lumpy-jaw."

**Etiology.**—The ray fungus, actinomyces or streptothrix bovis, is the usual cause of the disease. It appears under the microscope as a mass of branching threads and sometimes spores are seen. In the later stages the typical radiating threads with clubbed ends may be found, though these are more commonly present in the disease as it affects cattle than in human beings. The parasite stains with basic aniline dyes, and is gram positive. Acid-fast forms have been described. Growth of the organism on artificial media is difficult, and it is particularly difficult to obtain in pure culture uncontaminated by pyogenic organisms. C. K. Bryant (Dental Cosmos, February, 1922, p. 198) has been able to obtain several strains by first inoculating tubes of Loeffler's blood serum to which has been added a few drops of human blood, and incubating under anaerobic conditions by covering the medium with sterile mineral oil. Subcultures thus obtained were found to grow aerobically on almost all media. The organism is believed commonly to gain entrance into the body by grain or straw introduced into the mouth, causing a lesion of the mucous membrane of the mouth or of the respiratory or digestive tracts. The tonsils or carious teeth may be points of entrance. Thus, the disease is particularly apt to occur in persons residing in the country.

Actinomycosis spreads by a gradual invasion of the tissues surrounding the point of inoculation. It spreads without regard for anatomic boundaries. The lymphatics are not apt to be involved except when the disease is associated with an infection by pyogenic organisms. Metastasis may take place through the veins, and the lungs are particularly liable to be the seat of secondary deposits.

**Symptoms and Diagnosis.**—Where the superficial tissues are infected, there first appears a small, soft, tender nodule which slowly spreads, giving to the skin a purplish mottling. The nodules break down, forming sinuses which discharge a thick pus in which the typical "sulphur-granules" are found. These granules are yellowish, gritty, and usually not larger than a pin head. They are composed of calcareous material and masses of the fungi, which can be demonstrated under the microscope. One can never be certain of the diagnosis without microscopic demonstration of the organism in the granules. Great care is necessary in preparing slides for examination, as too much pus or blood will render the search fruitless. It is believed that many cases are overlooked owing to lack of attention to this detail. The lesions show a tendency to heal in one portion and break down in another. In healing, much cicatricial tissue is formed. The lesions are tender, but, as a rule, are not accompanied by great pain. The chronic cases rarely present constitutional symptoms, such as high fever. In acute cases complicated by infection with pyogenic organisms, or by the formation of metastases, symptoms of septicemia or pyemia may be present. The clinical course of actinomycotic infection in the region of the jaws at first may resemble very closely ordinary osteoperiostitis and cellulitis following dentoalveolar infection. The patient frequently complains of soreness and loosening of one or more teeth, particularly lower molars, followed by swelling and induration of the side of the face and submaxillary region. Trismus, more or less marked, is nearly always present. It is only the duration of the symptoms, the lack of response to incision and drainage, and finally the appearance of the surface lesions, that lead to the suspicion of actinomycosis.

The **prognosis** of chronic and localized cases depends on the situation of the disease. Where vital organs are not involved, the chances for recovery are good. The principal danger lies in the introduction of pyogenic organisms into the lesions, which may result in septicemia or pyemia. The formation of metastases also renders the prognosis unfavorable. The mortality of superficial lesions is about 10 per cent, and of the deeper tissues about the jaws, about 30 per cent. It is always advisable to search for lung metastasis by x-ray examination of the chest.

**Treatment.**—Until recently, the most popular forms of treatment have been the internal administration of potassium iodide, and

total excision of the affected tissue. The latter is obviously impossible in the case of deep tissues of the face. Potassium iodide may be given in ascending doses of from fifteen to sixty or a hundred grains a day. Operative measures should consist in free opening, curettement and maintenance of drainage. The use of vaccines made up of killed cultures of the organism has met with considerable success, and should be employed whenever possible. Good results occasionally follow radium and x-ray therapy. Baracz (Zentralblatt für Chirurgie, May 6, 1922) has successfully treated 35 cases of actinomycosis by infiltrating the affected tissues with a weak solution of copper sulphate (½ to 1 per cent). From ten to 40 c.c. of the solution are injected every ten days to two weeks, two, three or four injections being necessary according to the severity of the case.

## ANTHRAX

Anthrax, malignant pustule, or wool-sorter's disease, is a disease caused by the anthrax bacillus, a spore-forming organism, which is transmitted to man in some manner from animals. It may be contracted from working around diseased animals, as in the case of butchers, by handling or tanning hides, by sorting hair or wool. Cases have been reported recently which developed from infected shaving brushes. The spores live for a long time on the hair taken from infected animals.

In *external* anthrax, which is most frequently seen about the head and neck, the symptoms appear in from three to six days after inoculation, in the form of an itching and burning papule with a red base, which soon becomes a vesicle. Other vesicles are formed about this, the base of the lesion becomes greatly swollen, and of a purple color, with a central depression. There is a great deal of surrounding edema and lymphatic enlargement. The pain may be only slight, but marked constitutional symptoms soon appear, the patient developing high irregular fever, chills, sweats, and delirium. The outcome is often fatal.

**Treatment.**—Operative treatment does more harm than good, as it tends to break down the barrier set up around the focus of infection with consequent spread of the disease. All forms of local treatment hitherto employed should be replaced by the local injection of antianthrax serum around the lesion every twelve to twenty-four hours. The serum should also be administered generally, by

the subcutaneous, intramuscular, and intravenous routes. (Regan, J. C., Journal A. M. A., Dec. 17, 1921.)

## Glanders

**Glanders** (Farcy, Malleus) is an infectious disease rather peculiar to the horse and caused by *Bacillus mallei.* It is sometimes transmitted to man by direct contact. The disease attacks the mucous membrane of the nose and mouth, is characterized by the formation of nodules—rarely diffuse indurations—which break down and form ulcers. It may be either acute or chronic, and its manner of outset may vary greatly. In the acute variety there is intense pain and early suppuration of the mucous membrane and lymph nodes, accompanied by high fever. The diagnosis is made possible from the history of exposure, the formation of ulcers, and the presence of the specific bacillus. The acute form is almost invariably fatal, while in the chronic form the death rate is about 50 per cent. The treatment consists in active local antisepsis.

A. T. Bristow cites the case of a man who was operated upon for a sinus leading to dead bone in the jaw. After curetting and removing the dead bone, the sinus healed. Later an abscess developed in the leg and one in the arm, which when opened gave pure cultures of *Bacillus mallei.*

# CHAPTER V

## TUMORS OR NEOPLASMS

**Definitions.**—A tumor is an autonomous new growth of tissue (Ewing). A more explanatory definition is as follows: A tumor or neoplasm is a new formation of cells which proliferate continuously and without control, serves no useful function, has an atypical arrangement of cells, and has, at least at the present time, no assignable cause for its existence.

The original meaning of the word tumor was swelling, but as it became known that many swellings were due to an inflammatory reaction or to some infection or injury, the word tumor was restricted to growths that were not known to be due purely to injury or to a recognized parasitic infection. As knowledge of pathology increased, certain enlargements that were formerly called tumors have, as their specific cause was discovered, from time to time been withdrawn from this classification and placed among the infectious diseases. It is probable that this process of elimination will continue indefinitely. The unmistakably inflammatory processes, such as pus infections, were early differentiated from tumors, but certain of the more chronic infections—among which are tubercle, actinomycosis, and syphilis—cause swellings that were often confounded with tumors. Even now it is sometimes difficult, clinically, to distinguish between them.

The most striking characteristic of a tumor is its independence of growth. Normal cells are under control in some way or other; they cease to proliferate after reaching the limit necessary for proper function. The growth of tumor cells is unlimited and uncontrolled except when their nutrition is interfered with. In the growth of tumor cells there is an attempt to imitate the structure of a normal tissue or organ. The more the cells differ from the normal in structure and arrangement, the more likely is the tumor to be malignant. Tumors serve no useful function, and may be dangerous either from secretion of poisonous substances or by mechanical interference with the function of neighboring organs.

**Causes.**—No definite cause for the proliferation of tumor cells can at present be advanced. All sorts of causes have been assigned.

Injury, severe or long continued, is a frequent predisposing factor in the production of certain types of cancer and possibly some other varieties of tumors. Instances of this are the carcinomas following exposure to x-rays and radium. Many tumors unquestionably arise from cells which have become displaced from their normal relations during fetal and postnatal development, or have persisted into adult life when they should have disappeared after their function in the fetus had been performed (Cohnheim's theory). Various microbes have been brought forward from time to time as the cause of tumors, but the parasitic origin of these growths has not been proved.

**Manner of Growth.**—Tumors grow entirely by multiplication of their own cells, not by transformation of normal cells into tumor cells. The cells multiply by mitosis or indirect division. Tumors grow in two ways: (1) by expansion, (2) by infiltration. The two types of growth are often combined.

In growth by *expansion*, the tumor cells push the surrounding normal cells before them, compressing the latter and causing them to atrophy and disappear. At the same time, more or less connective tissue of the part remains in the tumor, furnishing a blood supply for its cells. This type of growth is characteristic of benign tumors. In growth by *infiltration* the tumor cells penetrate between the cells of the tissues in which they arise. By pressure, and by using up the nutrition they lead to necrosis or atrophy and disappearance of the normal parenchymatous cells of the part; only the original connective tissue and the blood vessels ordinarily persist in the end.

**Structure.**—All tumors consist of two parts: of the tumor cells, and of the stroma. The tumor cells form the parenchyma, and as distinguished from the stroma, are the true essential part of the tumor. The stroma is entirely secondary, and is a supporting tissue furnished by the surrounding parts. The cells of the stroma are not tumor cells, although in a fibroma the nature of the two kinds of cells is identical.

**Tumor Cells or Parenchyma.**—The true tumor cells tend to differentiate in exactly the same way as do the normal cells to which they correspond. In slow growing tumors they may resemble normal cells perfectly. In rapidly growing tumors the cells may differ so widely from the model that it cannot be recognized. The nuclei often show much variation in size and are often larger than those in normal cells. The cells themselves frequently exhibit

marked differences in size and shape. Rapidly growing tumor cells often show exceedingly numerous mitotic figures, and multiple mitoses are not infrequent.

**Stroma.**—The stroma of tumors ordinarily consists, like that of normal organs, of connective tissue and blood vessels. The amount of stroma varies greatly in different tumors. The blood vessels of the stroma of a tumor may vary greatly in number and size. Tumors are subject to many of the retrograde changes seen in normal tissues. They may undergo hemorrhage, necrosis, infection from bacterial invasion, etc.

**Gross Characteristics.**—*Size.*—Tumors vary greatly in size, from microscopic collections of cells to enormous masses. Large tumors are not so common nowadays because they are usually removed earlier in their development.

*Shape.*—Tumors tend to be spherical, but may be nodular, lobulated, polypoid, pedunculated, papillary, fungoid, etc.

The *color* varies according to the structure of the tumor.

The *consistence* of tumors depends sometimes on the amount and character of the intercellular substance (fibroma, osteoma); at other times on the amount and character of the parenchyma (carcinoma).

**Recurrence.**—Where there is a failure to remove all of a tumor, the part left behind will continue to multiply until another tumor mass is formed. This is termed a recurrence. The danger of recurrence is so well recognized that surgeons usually remove a wide margin of apparently normal tissue around a tumor.

**Metastasis.**—When tumors invade lymph or blood vessels or cavities, cells may be set free and be carried to other points and there continue to grow and proliferate. A secondary growth arising in this way, entirely apart physically from the original or primary tumor, is called a metastasis. Metastases occur most frequently by way of the lymphatics (carcinoma), less commonly through the blood vessels (sarcoma).

A tumor is said to be *malignant* or *benign* according as it does or does not endanger the life of the individual. A *malignant* tumor is one which grows rapidly, is not encapsulated, infiltrates and destroys the surrounding tissues, forms metastases, and tends to recur after removal. A *benign* tumor is one which grows slowly, is usually encapsulated, enlarges by expansion, does not form metastases, and does not recur after removal. The formation of metastases is perhaps the most important evidence of malignancy.

## CLASSIFICATION OF TUMORS

In classifying tumors we differentiate them in accordance with their histologic structure and the embryonic layer from which their cells are derived.

**Group 1. Connective tissue type. Mesoblastic.**

(a) Fibroma—Fibrous connective tissue.
(b) Chondroma—Cartilage.
(c) Osteoma—Bone.
(d) Myxoma—Mucous connective tissue.
(e) Lipoma—Fatty tissue.
(f) Angioma—Blood vessels.
(g) Lymphoma—Lymphatic tissue.
(h) Lymphangioma—Lymph vessel tissue.
(i) Myeloma—Bone marrow.
(j) Sarcoma—Embryonic connective tissue.

**Group 2. Muscle tissue type. Myoma.**

(a) Leiomyoma—involuntary muscle or smooth muscle.
(b) Rhabdomyoma—voluntary or striated muscle.

**Group 3. Elements of nervous system.**

(a) Neuroma—Nerve fibers.
(b) Glioma—Neuroglia tissue.
(c) Neuroepithelioma—Neuroepithelium.

**Group 4. Endothelial type.**

Endothelioma—Endothelial cells from lining of blood vessels, etc.

**Group 5. Epithelial type. Epiblastic and hypoblastic.**

(a) Papilloma—Pavement epithelium, with supporting tissues in normal arrangement.

(b) Adenoma—Glandular epithelium, with supporting tissues in normal arrangement.

(c) Carcinoma (cancer)—Embryonic epithelial tissue.

**Group 6. Complex tissues.**

(a) Simple mixed tumors, in which there is present more than one type of neoplastic tissue—fibromyoma, osteosarcoma, etc.

(b) Teratoma—composed of tissues and organs of one, two or three germinal layers—odontoma, dermoid cyst.

(c) Embryoma—composed of tissues from the three germinal layers in more or less orderly imitation of a fetus.

Tumor cells tend to differentiate as the cells from which they arise would do under normal conditions. If the growth of the tumor is slow the differentiation of the cells may be as perfect as in normal tissues, although as a rule it is not. When the cell mul-

tiplication is rapid the differentiation of the cells is less marked and may be entirely wanting. In other words, the cells in malignant tumors resemble cells of embryonal tissue. The nomenclature of tumors is not entirely satisfactory, and there is considerable lack of uniformity in naming certain varieties. The term *cancer* was originally applied to all malignant tumors. It is now confined to malignant new-growths of an epithelial nature. The term *sarcoma* has long been applied to all malignant tumors of a non-epithelial nature.

The more common tumors of the various types will now be considered more in detail.

## CONNECTIVE TISSUE TUMORS

(a) **Fibromas** usually form spherical or rounded nodular masses, rather hard in consistence. As a rule they are surrounded by a capsule and are pathologically and clinically benign, except when they exert pressure on vital organs. They are most commonly found beneath the skin.

(b) **Chondromas** are mesoblastic tumors, the cells of which tend to differentiate into cartilage cells. These tumors may attain a large size, are usually lobulated or nodular, and extremely hard to the touch. They usually arise from perichondrium and periosteum, but occasionally originate in the soft tissues and internal organs. They are found most often, therefore, in connection with the skeleton.

(c **Osteoma and Osteosarcoma.**—These are mesoblastic tumors the cells of which tend to differentiate into bone cells. These growths usually start in connection with bone or periosteum, and may attain a very large size. They form spherical or nodular tumors, of great hardness. The osteomas grow slowly while the osteosarcomas grow more rapidly, invade the normal bone, often extending to muscle and other soft tissues, and form metastases.

(d) **Myxomata** are tumors of mesoblastic origin the cells of which tend to form mucin. The type cell of this group is the mucous connective tissue cell found in the jelly of Wharton in the umbilical cord. The tumors are translucent and jelly-like, owing to the presence of the mucin between the cells, the cells themselves being stellate.

(e) **Lipoma.**—This is a common tumor of mesoblastic origin composed of fat cells. Lipomas are benign tumors which usually grow slowly and expansively, and are surrounded by a connective tissue

capsule. They are usually soft, occurring most frequently subcutaneously, and may attain a large size.

(f) **Angioma.**—Tumors belonging to this group are derived from blood vessels, and may be either of the capillary or the cavernous type. In the former numerous capillaries are found lying in a connective tissue stroma. In the cavernous type large spaces are formed, containing blood. Angiomas usually occur in the skin and subcutaneous tissue. The cavernous type often forms a large red area on the skin (portwine stain).

(g) **Lymphomas** are tumors derived from the lymphocyte or small mononucleated cell found in lymph glands. Lymphomas are characterized by noninflammatory enlargements of the lymphoid tissue in various parts of the body, such as the superficial lymph nodes, spleen, etc.

(h) **Lymphangiomas** are tumors similar to angiomas, composed of an overgrowth of lymph vessels.

(i) **Myeloma** is characterized by a proliferation of the cells of the bone marrow. One variety is occasionally seen in the jaws in the form of giant cell epulis.

(j) **Sarcoma.**—Sarcoma is a term applied to all malignant tumors that arise from connective tissues—such as bone, muscle, or fascia—in contradistinction to those that arise from endothelial or epithelial cells. The metastasis of a sarcoma is usually through the blood stream and rarely through the lymphatics. Sarcomata are often classified according to the structures they represent. Thus we have osteo-, fibro-, and chondro-sarcomata, etc., when bone, fibrous tissue, and cartilage can be respectively recognized in the growth. When the cells fail to develop sufficiently to recognize the tissue from which they form, they are classified according to size and shape of the component cells, as round cell, spindle cell, and giant cell sarcomata. The smaller the cells as a rule, the more malignant the growth. Thus, small round cell sarcoma is very malignant, while giant cell sarcoma has comparatively little malignancy. Melanotic sarcoma is a sarcoma containing pigment, and is extremely malignant.

## ENDOTHELIAL TYPE

**Endothelioma.**—Endotheliomata arise from the endothelial cells of the blood vessels or serous cavities. The blood vessels and lymphatic tissues arise originally from the same germinal layer as

does the connective tissue: the mesoblast. Endotheliomata somewhat closely resemble sarcomata, from which they have more recently been differentiated.

## EPITHELIAL TYPE

The epithelial new growths form the largest and most important group of the simple tumors. The type cells from which they are built up are the epithelial cells which occur normally in great variety, and differ among themselves in many ways. Some are ciliated, others contain characteristic granules, etc. The cells of epithelial tumors cover surfaces or grow in solid cords or masses. The surfaces may be elevated or may be depressed in pockets or folds. In these different ways of growth the epithelial cells are supported and nourished by a stroma composed of connective tissue and blood vessels.

Various names have been applied to epithelial tumors. These names are based partly on the histologic structure of the tumors, partly on whether they are clinically benign or malignant. The following three forms are the most important:

**Papilloma.**—An epithelial tumor in which the cells cover projecting processes of stroma.

**Adenoma.**—An epithelial tumor in which the cells form gland-like masses.

**Carcinoma.**—Carcinoma, or cancer, is a growth of epithelium that breaks through the normal limiting basement membranes and invades the subepithelial tissues. This is the chief distinguishing feature between cancer and a benign papilloma or wart. The cells of the latter grow toward the surface, and never break through the limiting basement membrane. The metastasis of cancer takes place through the lymphatics, and it is for this reason that the regional lymph nodes always become infected with the growth. Carcinomata are classified mainly by the kind of epithelium from which they grow, those arising from the surface being squamous carcinomata (epithelioma), and those from glandular epithelium being adenocarcinomata. In the nose and accessory sinuses the normal ciliated epithelium may be replaced by squamous epithelium at the site of a developing carcinoma. Carcinomata are also classified as medullary and scirrhous, according to the softness or hardness of the growth.

## MIXED TUMORS

(a) **Simple mixed tumors**—in which there is present more than one type of tissue—are common. For instance, we may have a tumor composed of fibrous and muscular tissue, called a fibromyoma. Mixed tumors are occasionally seen in the parotid gland, and consist of glandular tissue, fibrous tissue, muscular tissue, fat, cartilage, etc.

(b) **Teratomas.**—The tumor in this group of most interest to us is the odontoma, derived from tooth tissue, and will be discussed in greater detail later.

## CYSTS

Tumors that contain fluid or semifluid material are called cysts. A cyst always possesses a definite wall of special tissue that has grown to accommodate its contents—not simply stretched. This eliminates from the class of cysts such accidental accumulations as pus or blood, and also the simple distention of a normal duct with fluid. For example, an abscess, hematoma, or a recent obstruction of Wharton's duct does not constitute a cyst; but a permanent obstruction of a sublingual duct, which is one form of ranula, is a true cyst. Fluid areas in a solid tumor may sometimes be spoken of as a cystic degeneration.

**Diagnosis of Tumors.**—All tumors are characterized by swelling. The diagnosis of the individual form present is made by the location of the growth and the other characteristic features that have been given. It is chiefly important to differentiate tumors from inflammatory swellings. A positive diagnosis can be made by microscopic examination of tissue excised from the growth. This procedure is not recommended as a routine practice unless a complete operation is done, as in the case of some malignant tumors it is apt to invite metastasis by opening up blood vessels for the entrance of tumor cells.

**Treatment of Tumors.**—It is a general principle that tumors should be removed surgically if possible. There are also several adjunct therapeutic measures, to be used in combination with surgery, such as electro-coagulation, radium, and the x-ray.

# CHAPTER VI

## HEMORRHAGE, SHOCK, AND ALLIED COMPLICATIONS

While most of the complications that may follow surgical operations are preventable, they will nevertheless occasionally arise. When conditions are present that predispose to any of these complications, such conditions may usually be recognized in a careful preoperative examination, and be corrected by proper treatment.

### HEMORRHAGE

Hemorrhage is the escape of blood from the blood vessels. It may be either spontaneous or due to traumatism. The blood may either escape from the surface of the body, into the tissues surrounding the blood vessels (*extravasation*), or into one of the internal body cavities, such as the peritoneal cavity or a joint.

There are three anatomical varieties of hemorrhage—arterial, venous and capillary.

1. **Arterial hemorrhage** is caused by section or rupture of an artery. There is a flow of bright red blood, which occurs in spurts coincident with the heart-beat.

2. **Venous hemorrhage** is caused by injury to a vein. There is a continuous flow of dark colored blood.

3. **Capillary hemorrhage** is characterized by a steady oozing of blood from a wound.

The clinical varieties of hemorrhage are primary, intermediate and secondary.

1. **Primary** hemorrhage occurs immediately after division of a blood vessel.

2. **Intermediate** hemorrhage occurs within twenty-four hours after the injury and is due to the slipping of ligatures or the expulsion of intravascular clots on restoration of normal blood pressure.

3. **Secondary** hemorrhage usually occurs some days after the operation or injury. It may follow suppuration or the separation of the sloughs, and presents a special difficulty, inasmuch as the vessels involved may be very friable or held in a dense inflammatory mass.

**General Symptoms of Hemorrhage.**—A patient suffering from loss of blood first feels faint, and possibly nauseated; if the erect position is maintained, he may fall. With moderately slow progressive hemorrhage there is thirst and restlessness; there is an increasingly rapid and weak pulse, with a continuous fall of blood pressure; the skin is often moist and clammy, and both the skin and mucous membrane become pale. Eventually there is air hunger. The condition closely resembles the restless form of shock, from which it is often difficult to distinguish when the bleeding does not show on the surface.

**Prevention of Hemorrhage.**—In surgical operations the unnecessary loss of blood is to be rigidly avoided, and the control of hemorrhage should always be considered in planning the technic. Whenever possible, vessels should be isolated and temporarily or permanently ligated before being cut, and every cut vessel that continues to give a flow sufficiently large to be recognized as an individual source of hemorrhage should be controlled.

A deficiency in the clotting power of the blood may be responible for an abnormal amount of hemorrhage. The formation of the clot depends on the presence of three elements—thrombogen, thrombokinase (both supplied by the blood or the tissues with which the blood comes in contact), and calcium ions (also normally present in sufficient quantity). If, for any reason, it is suspected that the clotting power of the blood is below normal, the clotting time should be ascertained, and, if sluggish, an attempt should be made to remedy the defect. Normal blood coagulates in from three to five minutes after having been shed. Clotting may be delayed in several conditions, among which may be mentioned jaundice, anemia, hemophilia, and acute alcohol poisoning.

A very simple, yet practical, way of determining the coagulation time is to obtain a drop of blood, about 8 or 10 millimeters in diameter, on a clean glass slide. In obtaining the blood, the end of a finger or the lobe of an ear is stuck with a cutting needle. The blood must flow without squeezing the part, as squeezing lessens the clotting time. The point of a clean needle is passed through a new place on the edge of the drop every minute until a distinct string of fibrin can be made to adhere to the needle, which occurs just a little before the true clot is formed. This method is sufficiently accurate for practical purposes. A more exact way is to draw the blood up into a freshly made capillary tube 1 or ½ millimeters on its inside diameter. A short section of the tube is broken

off each minute, or a part of the blood is blown out of the tube at minute intervals. As soon as the clot forms, the fibrin is seen stretching between the separate tube ends, or it can no longer be expelled by blowing. Dorrance has devised an accurate yet simple instrument for estimating the coagulation time.

If calcium is the element lacking in cases of delayed clotting, it can be easily supplied. Between 1 and 4 grams of calcium lactate are given daily for several days before operation when the natural clotting time is over four minutes. It is not unusual for the clotting time to be reduced by this from as high as seven down to three minutes or less. Lack of calcium is not always the fault, and for this reason various other therapeutic agents have been proposed. Thirty cubic centimeters of a freshly made serum from an animal may be injected subcutaneously. Where conveniences for preparing fresh serum are not at hand, an antitoxic serum may be used. The lack of clotting may be due to an increased percentage of salts in solution, as the presence of bile salts, or to certain diseases or poisons, as sepsis, scurvy, hemophilia, or purpura. When possible, the causes of these conditions should be treated; or by serum injections or by direct transfusion of blood, a blood that will clot should be obtained before an operation is undertaken. The clotting time in the individual may vary from time to time. When reduced by the administration of calcium, it has been noticed that it begins to rise again within a few days after the drug is withdrawn. As hemorrhage continues, the clotting time decreases.

**Control of Hemorrhage.**—Hemorrhage is designated as arterial, venous, or capillary, according to its source, but as a matter of fact in almost every instance it is a combination of all three, with one predominating. To intelligently treat bleeding, one must understand and work in harmony with the natural hemostatics, without the existence of which all the surgeon's efforts would be futile. These are the retraction and contraction of the cut vessel, the lowering of the blood presure by diminution of the strength of the heart's action and of the arterial tone, and most important of all, the clotting of the blood. The clotting is facilitated by the retracion and contraction of the vessels and by the lowered blood pressure.

Arterial bleeding is usually controlled by digital pressure, forceps pressure, torsion or ligation of the bleeding ends, or by ligation of the vessel and tissues *en masse* by means of deep sutures. Bleeding from the vessels situated in bony canals, such as the inferior dental or posterior palatine, may be controlled by inserting a peg, or pieces

of muscle, or connective tissue, into the canal, or by occluding it by pressing in a soft piece of wax. The formula of Horsley, carbolic acid, 1 part; olive oil, 2 parts; white wax, 7 parts, is very serviceable. The wax is sterilized by heat, and while still liquid is floated out on cold sterile water. Pieces of the congealed wax may be forced into the bone spaces and canals. When the bleeding point cannot be attacked directly, the outflow can be lessened and clotting favored by tying the artery any place proximal to the bleeding point. Where an artery has few and small anastomoses, such as the lingual, this plan is very effectual.

Ligatures, whether of silk or catgut, should be drawn just tight enough to close the lumen of the vessel and to prevent slipping. They should not cut any of the coats, which would predispose to secondary hemorrhage. If there is not a sufficient amount of the vessel exposed to insure the ligature against slipping, the strand should be engaged in the tissues by means of a needle. The vessels should be tied with a square knot, and the forceps should be released just as the first tie of the knot is drawn tight. Except on large vessels, as a cut lingual, only catgut ties should be used in closed wounds of doubtful asepsis. Silk may be used in open wounds and in aseptic closed wounds.

In wounds of any depth, especially if the vessels cut are not too large, the bleeding may be controlled by a temporary packing with gauze. If this is done aseptically, the wound may on the second, third, or fourth day be closed by secondary sutures, which might have been put in at the time the packing was placed. If the wound is not sufficiently deep to maintain the packing, it may be fixed in place with sutures, the pressure of a bandage, or, in some parts of the mouth, by fastening the lower to the upper jaw by ligating the teeth, or less effectually by a Barton bandage.

One of the most effectual and convenient ways of controlling the bleeding in most wounds in the face, mouth, and scalp is by the use of deep approximation sutures, which should be drawn just sufficiently tight to accurately approximate the cut surfaces. Unless there is a grave fault in the clotting power, this will be sufficient. Greater tension will cause necrosis and risk of sepsis along the suture tracts.

Bleeding veins had best be tied, but a light pressure will control the flow.

In average individuals the bleeding from capillaries and small vessels needs no treatment. Continued capillary oozing is almost

always due to slow clot formation, and may be treated by lowering the blood pressure and increasing the clotting time, and also by the local application of styptics, pressure, and means that stimulate the contraction of the local vessels. The direct application of the extract or powder of suprarenal bodies, preferably in the form of the alkaloid—as the 1:1000 solution of adrenalin chlorid, for example—causes a contraction that will often control the bleeding from small vessels until the clot has had time to form. The application of cold, usually in the form of ice or cold water—either directly to the bleeding area or, where this is not practical, to some related area—also lessens the caliber of the vessels, and is therefore helpful. Hot water will cause a contraction and also hastens clotting.

**Hemorrhage Following Tooth Extraction.**—Considering the large number of teeth extracted, hemorrhage is not a very frequent complication, but it may be a very serious and even fatal one. If undue hemorrhage occurs, the alveolus is to be syringed out with warm water to dislodge any clots, as the presence of a large extravascular clot may favor the persistence of bleeding. One is sometimes surprised, on cleaning the clots out of a bleeding wound, to find that the flow rapidly diminishes and ceases. Careful inspection should be made to determine the exact source of the bleeding. Sometimes it comes from the gum margin, in which case the flow may be immediately arrested by a suture through the gum on each side of the tooth socket. If the bleeding comes from the depths of the socket, a little tannic acid powder on gauze or cotton packed into the socket will frequently arrest the bleeding. Another agent very useful for this purpose is a tissue extract known as thromboplastin, with which the gauze packing is soaked. If this does not control the bleeding, two to four thicknesses of gauze are laid over the surface of the packing and the adjacent gums, and the whole is covered with soft modeling composition. This should be of sufficient bulk to be in contact with the opposing gums or teeth when the jaws are closed. Before the compound is hard, the jaws are closed firmly and held in this position with a Barton bandage or even by wiring the upper and lower teeth together. Measures should also be instituted to increase the clotting of the blood. The packing in the tooth socket should not be disturbed for at least forty-eight hours.

After hemorrhage has persisted for a certain time, the blood pressure continuously falls. The general, and with it the local,

blood presure is lowered by laying the patient in the recumbent position, insuring quiet with sedatives, and not resorting to stimulants. This is an imitation of the faint that often accompanies severe hemorrhage. To raise up or stimulate a patient who has fainted from the loss of blood is but to invite an increase of the bleeding. Certain drugs, such as the nitrates, will lower the blood pressure, but their employment has seldom been advocated. Morphine, though a stimulant, is most valuable in quieting both the mind and body. The use of vasoconstrictor drugs as styptic that cause a general contraction of the blood vessels, is on physiological grounds to be unqualifiedly condemned. Vasoconstrictors cause an elevation of blood pressure, which will outweigh the benefit derived from the relatively slight contraction of the blood vessels that occur at one point.

**Seondary hemorrhage,** due to sepsis, is best treated by cleaning out the wound with antiseptics, cutting instruments, or a cautery at a dull red heat, and the use of any previously mentioned means that circumstances dictate. An artery can be ligated at a distance to control bleeding from its trunk or any of its branches.

**Treatment of the Effects of Hemorrhage.**—With rare exceptions, according to our experience and opinion, neither stimulants nor transfusion, nor any other method of raising blood pressure, should be employed before the bleeding is at least temporarily controlled. If the condition of the patient seems critical, quiet should be insured, if necessary, with a little morphine given hypodermatically. The head should be on, or below, the level of the body; the limbs may be elevated, or even bandaged, to keep as much of the blood as possible circulating between the heart, the lungs, and the vital centers; the body should be kept warm by blankets and artificial heat. Hot-water bottles placed around an unconscious or semi-conscious person should be at a temperature of 115° F., and no higher, for otherwise the patient may be seriously burned.

Once the loss of blood is controlled after a severe hemorrhage, the vessels should be filled with normal saline solution at a temperature of 104° F. to 110° F. Fatal hemorrhages can occur through loss of fluid when there are still enough blood cells and plasma in the vessels and tissues to comfortably carry on function, if they could but circulate. A level teaspoonful of salt to a pint of water, boiled and cooled to 110° F., by setting the vessel in a pan of cool water, is a practical way of preparing the saline solution. It should be introduced either directly into a vein, under the skin, or into the

rectum at a temperature of 100° F. For want of a special reservoir, a sterilized fountain douche bag is usually accessible and is very effective. It is difficult to accurately gauge the amount of fluid that is slowly running from a rubber douche bag, but if the bag is hung on the ordinary spring balance scale that is usually found in every house, the flow can be gauged with some accuracy.

When a transfusion is done with saline, the blood is diluted, which may increase the clotting time. If it has not already been controlled, it will be more difficult to accomplish this after than before the saline transfusion, on account of both increased blood pressure and decreased clotting power. If repeated hemorrhage and saline transfusions alternate several times, a blood of very poor clotting power will result. When not satisfied that the source of the bleeding is permanently controlled, the transfusion should be with blood.

**Blood Transfusion.**—Formerly direct blood transfusion was done by connecting a blood vessel of the donor, who was free from transmissible taint, to a vein of the patient in such a way that the blood passed from the donor to the patient or recipient. Of late years, however, simplified indirect methods have been more commonly used, the blood being withdrawn from the donor, into a flask containing sodium citrate to prevent coagulation, and then injected into the recipient. Lewisohn's experiments[1] have shown that 0.2 per cent of sodium citrate in blood is sufficient to prevent coagulation outside the body for two or three days. Five grams of sodium citrate represent the largest amount that can be safely introduced into an adult. One thousand c.c. of blood containing 0.2 per cent citrate only represents 2 grams of sodium citrate. The technic employed by Lewisohn is most simple.

1. *Obtaining the Blood from the Donor.*—A tourniquet is applied to the donor's arm and one of the veins at the bend of the elbow punctured. A large cannula is used so the blood will flow rapidly. The blood is allowed to fall into a graduated glass jar which contains 2 per cent sodium citrate solution in quantity necessary to make a 0.2 per cent solution in the amount of blood to be given. For example, if we want to give 450 c.c. of blood, we add this to 50 c.c. of the 2 per cent citrate solution. The blood is well stirred as it falls into the jar. Care must be taken never to have less than 0.2 per cent of sodium citrate, or the blood will coagulate. A

[1]Journal of the A. M. A., March 17, 1917, 828.

slight surplus of citrate solution will prevent this and can be added with perfect safety.

2. *Infusion of Blood into the Recipient.*—The citrated blood is either administered through a funnel or transferred to a glass infusion jar. The patient's vein usually has to be exposed through a small incision. The cannula is inserted and attached to a funnel or infusion jar which contains 20 or 30 c.c. of physiologic saline solution. The citrated blood is then poured into this receptacle and allowed to flow into the vein by gravitation.

Before resorting to transfusion in any case, whenever possible a Wassermann test must be made on the donor, and the blood of the donor and recipient must be tested for agglutination and hemolysis. Neglect of these precautions may bring disastrous results.

The simplicity of Lewisohn's technic renders it available to all, and makes it superior to all other methods of transfusion, either direct or indirect, for general use.

## SHOCK

Shock is a state of prostration characterized chiefly by depression of the circulation and muscular relaxation, following severe bodily injury, operation, or associated with intense pain or emotional disturbance.

**Etiology and Pathology.**—Fear, loss of blood, rough handling of richly innervated tissues and nerve trunks, chilling of the surface, and prolonged operations are all conducive to shock. Old people, with high blood pressure, stand the loss of blood poorly, and the supervening shock comes suddenly. Shock is accompanied by a fall of blood pressure; in fact, the latter may be taken as an indication of the degree of the shock. An enormous amount of experimental work has been done in the investigation of shock, and many theories have been brought forward to explain its occurrence. Most investigators agree that shock is not due to deficiency of carbon dioxide in the blood, disturbance of the respiratory and cardiac centers, depression of the vasomotor center, or primary failure of the heart. The summary given by Cannon in Keen's Surgery is a concise statement of all that is definitely known about this condition. It is as follows: "In a review of the observations on shocked men and the experimental evidence it appears that the central condition is a low blood pressure due to diminished volume of circulating blood, that this condition is made worse by cold,

that if the pressure falls below a critical level the tissues suffer from lack of oxygen, that persistence of this insufficient circulation may induce irremediable damage to the circulatory system, and that in the shock state there is peculiar sensitiveness to ether and chloroform anesthesia. The rational treatment of shock must take into account all these circumstances."

**Symptoms.**—In the ordinary form of shock the patient lies perfectly quiet, with the eyelids half closed and the limbs in the position that chance may have placed them; conscious, but paying no attention to anything around; able to speak feebly and slowly, but entirely incapable of any mental effort. The face has lost all expression; the skin is cold, pale and clammy, that on the forehead often being covered with perspiration; the pulse is frequent, generally more or less irregular; the respiration is shallow, and the temperature far below normal—sometimes as much as three or four degrees. In the worst cases, such as are almost certain to prove fatal, there is complete absence of the sense of pain. Vomiting is of frequent occurrence.

**Treatment.**—The expeditious operator, who uses ordinary judgment, will seldom have to deal with shock of his own production. The patient should have his fears allayed before the operation. During the operation he should be kept dry and enveloped in woolen blankets. Excessive loss of blood should be immediately followed by rectal, subcutaneous, or intravenous infusions of salt solution. Where practical, large nerve trunks should be blocked by the injection of a 1 per cent solution of novocaine directly into the sheath before they are cut.

Varied as are the views as to the precise nature of shock, there is an unanimity of opinion that the prime essentials in the treatment are bodily warmth and mental and physical rest. Warm blankets and hot-water bags, or bottles, will insure the former; while for the latter we are much dependent on the behavior of those around the patient. Morphine in small doses hypodermatically is often very useful. The patient should be in the recumbent position with the foot of the bed elevated to assist return of blood from the extremities. Because of a supposed loss of vasomotor control and consequent sequestration of blood in the abdominal veins and extremities, bandaging of the limbs in severe shock has been a common practice. The value of stimulants in shock is a mooted question. If a stimulant is to be administered, it is possible that an ordinary hypodermic syringeful of camphorated oil (camphor gr. i,

olive oil m.v.) injected every half hour will be found as useful as any and open to fewer objections. One to 2 pints of normal saline solution should be administered intravenously or hypodermically. This should be supported and sustained by adrenalin and atropin.

**Syncope,** or fainting, is a mild degree of shock, characterized by a temporary anemia of the brain. It is of sudden onset and short duration. The face suddenly becomes blanched and moist, nausea may be complained of, the pulse is small and rapid, and the individual sinks to the ground unconscious for a few moments.

**Treatment.**—Loosen the clothing about the neck to assist respiration, place the patient in a recumbent position, allow fresh air to enter the room, douche the head with cold water, and allow the patient to inhale aromatic spirits of ammonia. As he recovers consciousness administer one dram of aromatic spirits of ammonia in a little cold water by the mouth. Syncope when threatened may often be averted by thrusting the head of the sitting patient down between the knees and holding it there for a few seconds until the color returns to the face.

There are other postoperative complications, but the expeditious operator who makes careful inquiry into the functional condition of the vital organs, who conserves the vital forces, and early establishes elimination will have a relatively limited personal acquaintance with postoperative complications.

## POSTOPERATIVE PNEUMONIA

Postoperative pneumonia is more apt to occur in elderly people. The determining cause is irritation from ether; aspiration of mucus, blood, or stomach contents; exposure and chilling during or after the operation; or sloughing in the wound. A predisposing cause is impaired circulation. The quantity of ether given should be the minimum necessary.

The function of the lungs is augmented, and pulmonary complications are rendered less likely, by placing all patients in a sitting posture in bed as soon as they come from under the anesthetic. This is especially important with weak or elderly people. It is not practical or necessary with infants or young children. All should be well protected during and after operation.

## SUPPRESSION OF URINE

This is best avoided by assuring kidney function before operation and limiting the quantity of ether. Contrary to a somewhat popular practice, patients should not be dehydrated before or after operation, but may receive fluids up to two hours before the operation, and by the stomach as soon after as water can be swallowed. We also avoid drastic purges. When the excretion of urine is deficient, broken doses of calomel, and rectal, subcutaneous, or intravenous saline infusions, and possibly digitalis and sweating, are indicated.

## ACETONURIA

Owing to a derangement in metabolism, there is sometimes found a condition in which acetone, oxybutyric acid, or diacetic acid is formed in excess and liberated into the circulation. When this occurs as a postoperative complication, it is supposed to be due to the anesthetic, especially chloroform. It causes dryness of the tongue, excessive thirst, and asthenia, and may be recognized by a sweet odor on the breath and the presence of acetone or diacetic acid in the urine.

This complication is comparatively common in children, and is combated by withholding protein foods, the establishment of free elimination, and neutralizing the poison by giving bicarbonate of soda in medium-sized doses—2 grams, or 30 grains, every six hours.

## CHAPTER VII

## WOUNDS AND INJURIES OF SOFT PARTS

Injuries may vary from slight scratches and bruises to total destruction of a part, from scalds of the mucous membrane to burns involving immense loss of tissue. There are four points to consider in dealing with any wound or injury, namely, (1) the extent of the injury, including the determination of the structures involved, (2) the possible presence of a foreign body in the wound, (3) the probability of sepsis, (4) the repair of the injury.

Injuries of the soft parts may be classified in general as abrasions, closed wounds or contusions, open wounds, and burns.

An **abrasion** is a slight injury involving the rubbing or scratching off of part of the skin or mucous membrane.

A **contusion** is an injury to an organ or to the subcutaneous tissues, due to a blunt force, in which the surface remains intact, and may be produced by falls, kicks, blows, etc.

The tissue structure is torn, blood-vessels are ruptured, and there is an effusion of blood and lymph. If a large vessel is ruptured, there may be a considerable extravasation of blood into the tissues **(ecchymosis)**, or there may be a distinct cavity formed in the tissues, containing a collection of blood **(hematoma)**. This is usually gradually absorbed, but may undergo suppuration. A **petechia** is a small ecchymosis. As extravasated blood is absorbed it undergoes chemical changes, giving rise to a succession of colors, the part being first red, then in turn purple, black, green and yellow.

The **symptoms** of contusion are swelling, pain, tenderness, numbness and discoloration. Swelling, due to rupture of a blood vessel, appears very quickly after the injury, while later swelling is due to exudation of lymph. Discoloration of the skin appears early in superficial contusions, late in deep ones. A hematoma fluctuates at first, later becomes hard, due to coagulation of the blood. Secondary softening is usually due to suppuration, and is accompanied by the symptoms of inflammation.

**Treatment.**—This in most cases consists in rest, compression, and application of cold to the part. If the swelling increases, due to rupture of a large blood vessel, an incision must be made, and the

vessel sought for and ligated. The only other indications for incision are persistence of the swelling for some weeks, infection and gangrene.

## OPEN WOUNDS

An open wound is an injury involving a breach in the surface. From their clinical significance, open wounds have been divided into four classes:

1. **Incised Wounds** are wounds in which the tissues are clean cut without bruising, and in which the depth is not out of proportion to the surface extent. In such wounds, it is usually easy to determine the exact tissues involved. Owing to the fact that vitality of the tissues is but little impaired, repair without sepsis is probable.
2. **Lacerated Wounds** are wounds made by a blunt object, in which the tissues and skin edges are torn.
3. **Contused Wounds** differ from incised and lacerated wounds in that the vitality of the tissue involved may be greatly impaired, and that sepsis or sloughing will be a possible complication.
4. **Puncture or Stab Wounds** are wounds of great depth compared with their surface extent. The examination of such an injury may leave one in considerable doubt as to the extent of the damage. If clean cut, as with the blade of a knife, there is less probability of sepsis than in an incised wound; but if any individual structures are to be repaired, or if there is a foreign body to be removed, enlargement of the original wound or the making of another incision will probably be necessary. If a punctured wound is made with a dull instrument, such as a stick driven into the tissues, the element of contusion is added. In this case sepsis and necrosis, if they occur, will be at a depth, and may necessitate enlargement of the wound or special incisions for drainage. When a punctured wound enters a body cavity, it is known as a **penetrating** wound.

## GUNSHOT WOUNDS

Under this heading are included all wounds made by war projectiles. They may be lacerated, contused, punctured or penetrating.

**Wounds Due to Shrapnel.**—Shrapnel consists of a metal casing containing numerous leaden or steel bullets. When the casing explodes, the bullets are scattered at varying velocities, and when

striking the body, produce considerable laceration of the skin and soft parts, often carrying in particles of clothing, etc. The bullets themselves frequently remain embedded in the tissues. When they strike bone such as the mandible they are apt to shatter it.

**Machine Gun and Rifle Bullet Wounds** consist usually of a small, clean wound of entry, and a larger wound of exit, the amount of injury to the intervening tissues depending upon the parts involved. Under actual conditions of modern warfare the nature of the wound produced is greatly modified by many factors. The axis of the bullet may be rotated so that it strikes the body at an angle sidewise owing to deflection from its original course by striking some intervening object. It may have been altered in shape or the casing may have been broken. After entering the body, the bullet may be flattened or otherwise altered in shape by striking bone. Any of the circumstances so change the shape and course of the bullet as to produce much more destruction of the tissues than if it had retained its original form and direction of flight. The size and appearance of the external wounds give no indication of the amount of injury done to the internal structures. With an apparently simple external wound, there may be very extensive shattering of the bone beneath, or destruction of important soft structures.

**Explosive Shells** are made of steel or iron, filled with highly explosive material. When they burst, large, irregular fragments are scattered far and wide, inflicting extensive jagged wounds. Infection from the earth, clothing, etc., is always carried into the wounds, which, together with the mechanical destruction of the tissues, renders them the most formidable and terrible of all war injuries.

In all types of gunshot wounds of the face and jaws, infection is practically always present, there is laceration of the soft tissues, often shattering of the bone, frequently with extensive loss of substance, fracturing of teeth, which may be carried to distant points and embedded in the soft parts, such as the tongue and floor of the mouth, and frequently retention of the projectile in the tissues.

## DETERMINATION OF THE EXTENT OF THE WOUND AND THE STRUCTURES INJURED

The method of determining the structures injured should be both anatomical and physiological, and will vary with the character of the injury. If the eye or the finger can penetrate a certain depth into an

incised wound, a fairly accurate estimate of the damage can be made on purely anatomical grounds. Again, if a probe can be passed into a punctured wound a certain depth and direction, we may be able to say that certain structures are injured, but to determine whether other neighboring structures have escaped, we may have to resort to the examination of function.

A completely severed muscle will lose its function. An injury of a motor nerve will cause a paralysis of its muscle or muscles, an injury of a sensory nerve will cause anesthesia, an injury to a blood vessel will cause hemorrhage, and an injury of a salivary duct will be evidenced by leakage of saliva. In this manner, by a careful examination, it is usually possible to form an accurate estimate of the anatomical damage.

## PRESENCE OF FOREIGN BODIES

The possible presence of a foreign body in a wound may be determined by the sum of several investigations: First, the history of the injury and, if possible, an examination of the instrument with which it was inflicted. If with a stick or knife, the determination that the point is missing will lead to the surmise that it may be in the tissues. If a bullet wound shows no hole of exit, the same conclusions may be reached; but the presence of a wound of exit does not exclude the possibility of a part of a lead bullet or pieces of clothing or misplaced bone fragments remaining. Presence of only one wound in case of bullet wound of the face may mean that the bullet made its exit through the open mouth. Feeling with the finger or probe may show the presence of a foreign body, but it is difficult to exclude it with the latter. Lastly, the presence or absence of bodies that are impenetrable to the x-ray may be determined by its use.

Before inserting a probe or anything else into a fresh wound, one should stop for a moment to consider whether the act will be productive of more good than harm. It is often difficult to follow the course of a deeply punctured wound in soft tissue with a probe, and one who attempts to do so will seldom be certain that he is following the track of a wound and not dissecting the tissues. Further, unless the probe and the mouth of the wound are clean, he may carry into the depths an agency of infection that failed to penetrate with the original injury. The same holds true, but to much less degree, with sinuses and abscess cavities. We do not mean this as a condemnation of probes and probing, both of which have a distinct place in surgical

operations, but as a condemnation of the indiscriminating, thoughtless use of probes.

A foreign body deep in the tissues may sometimes be located by palpation, both by the objective resistance transmitted to the finger of the examiner and by the subjective pain or discomfort caused by a certain manipulation or manipulations. Foreign bodies can be approximately located by the x-ray by radiographing from two different surfaces and determining the point of intersection at which the foreign body is situated. Unless they are very difficult of access, they should be removed. If rather inaccessible, their location and character will determine our course. Hard structures—such as bullets, bits of knives or slate pencils—often remain in the tissues without causing further disturbance, and it may be better to wait for positive indications for their removal than to do greater damage by the immediate attempt. When it is seen that a foreign body is the focus of suppuration or the cause of nerve irritation, it should be sought, and removed if found. It is not well to attempt to find a deeply seated or a very small object by cutting down to its supposed situation through a straight incision. Success is more apt to crown the effort, and less damage will probably be done, if a semilunar incision is made through the skin and fascia and a flap turned. This will give room for examining and for dissecting between the more important structures as they are encountered.

## PROBABILITY OF SEPSIS

Infection of a wound depends on the lodgment of pathogenic bacteria in the wound in sufficient numbers to overcome the resistance of the tissues. The probability of infection will depend on the location of the injury, character of the injury, manner of its infliction, and time which has elapsed before treatment.

Clean-cut wounds are less liable to infection than open contused wounds; and punctured wounds, unless contused, are more apt to heal kindly than even incised wounds. Wounds that contain a foreign body—especially such as bits of stick, dirt, or clothing—are more apt to be infected than those that do not, and wounds that have been exposed for hours are less liable to remain clean than those that are immediately treated.

Men who confine their practice to the mouth cavity become so accustomed to see infected wounds and abscesses that result from tooth infections heal with relatively slight general disturbance, that they

may sometimes lose sight of the fact that infections do not always remain local, and that serious illness or death may result from apparently most trivial causes.

## TETANUS

In the consideration of wound infection, we have confined ourselves to the mention of sepsis, which usually means an infection with bacteria that causes suppuration. There are bacteria of other diseases that may gain access through wounds, but their development is dependent on the same conditions. One of these diseases requires particular mention, and that is *tetanus*. The bacillus of tetanus is rather broad in its distribution, and is found particularly in manure, street dirt, and the surface earth. Its entrance into wounds that have been inflicted by an object that has been in contact with the ground must be relatively common. The rusty nail that causes tetanus does so, not because it is rusty, but because it carries tetanus bacilli and because it inflicts a deep, lacerated wound. For the development of lockjaw it is necessary that the bacilli of tetanus develop in the wound, and they will not develop in the wound unless favorable conditions are found. It is not even necessary that the wound be deep, as scabs and slough may furnish the protection needed for the development of bacilli that lie under them.

If the clinical symptoms of tetanus become manifest within six days from the date at which the bacilli have actually entered the tissues, there is little that can be done to avoid a fatal issue. But its development can nearly always be prevented by the early injection of a prophylactic dose of tetanus antitoxin, and therefore, in every case of a wound that has been received in the street or on the ground, or inflicted with an instrument that has been in contact with the ground, 500 to 1500 units of tetanus antitoxin should be injected as soon afterward as possible.

## GAS BACILLUS INFECTION (GAS GANGRENE)

Another form of infection requiring special mention is that caused by a group of bacteria the commonest of which is the Bacillus aerogenes capsulatus of Welch, also known as the Bacillus perfringens. When a wound is infected with this organism, the tissues become swollen, and take on a mottled, purplish color. There is distinct crepitation, due to the formation of gas, associated with a thin, brown-

ish discharge from the wound. Gangrene of the soft tissues is due to interference with nutrition by pressure of the exudate and gas formation. If not checked in its early stages, the destructive process is progressive, and involvement of an entire limb may result. The general systemic effect of the toxin also may be rapidly fatal.

The organism seems to thrive only in dead tissue or tissue that has been changed by its toxin and not exposed to the air, its mode of attack being most frequently as follows: It first finds lodgment in necrotic tissue in a lacerated wound. As the organisms develop they evolve gas and toxins, which form intercellular pressure and poisoning, devitalize the surrounding healthy tissue, which in turn serves as a medium for the development of the bacilli, which cause gangrene of the attacked area. This vicious circle continues until the patient is overcome by the absorbed toxins or septicemia.

*Local Treatment* consists first of thorough cleansing of possibly infected wounds. The Carrel-Dakin treatment may be effective in doing this. When the tissues are attacked, free incision is indicated both for drainage and to relieve the pressure, followed by bathing in antiseptics, plain water or oxygenated solutions. Solutions of hydrogen peroxide have been injected into the tissues. Free incisions have given better results than amputations. The use of a prophylactic serum (Bull and others) seems to hold some promise. Free drainage of infected muscles is difficult on account of their bony relations. Therefore, before the suturing of any wound, the possibility of gas infection must be carefully considered. Gas gangrene infection in wounds of the face is practically unknown.

## HEALING OF WOUNDS

Wounds heal by means of a hyperactivity of the contiguous tissue. The first change in the tissues around the wound is a contraction of the cut blood vessels, which tends to stop the bleeding. Next there is a dilatation of the vessels with increased blood supply, and an exudation of plasma and white cells. Later there is an increase of the fixed tissue cells and a growth of new blood vessels. This growth or increase in the fixed tissue cells is largely confined to the connective tissues. Besides these, there are very few of the body tissues that have the power of reproducing themselves. Among the exceptions are the surface epithelial cells of the skin or mucous membrane. The endothelial lining cells of blood vessels and lymphatics and the axis

cylinders of nerves that still retain their connection with nerve ganglia are capable of reproduction.

The growth of the connective tissue cells forms an embryonal tissue called granulations—the red velvety surface that is seen in every open healing wound. This granulation tissue ultimately undergoes changes by which it is transformed into scar. It is almost entirely by means of scars that bind together the contiguous tissues that wounds are healed. Bone granulations become impregnated with lime salts and go through a series of changes, which may ultimately result in true bone tissue.

It has been found convenient to speak of the healing process as divided into two kinds—that which takes place in a clean, approximated wound, and that which occurs in an open or infected wound. The first is called healing by first intention, or primary healing, and the second is spoken of as healing by second intention, or healing by granulation. Though the healing in these cases differs clinically, still essentially it is identical.

When the surfaces of a clean wound are held in apposition, they are first agglutinated by the wound secretions and later are permanently united by granulation, which turns to scar. In open and suppurating wounds the surfaces cannot be immediately agglutinated by the wound secretions, nor can the granulations grow directly across the gap from one cut surface to another.

Granulation obliterates an open wound in the following way: As granulation tissue ages, its deeper and older layers contract. In a wound in the soft tissues this contraction lessens both the surface area and the depth by drawing the surrounding and underlying tissues into the defect. When a wound has healed, the scar will be much smaller than the original defect, and it is due to this contraction of the scar that the surface of a healed wound is often depressed. It is because the surrounding tissues cannot be drawn into the defect that deep cavities in bones heal very slowly, if at all.

When the granulation at the edge of the wound reaches the level of the surface epithelium, the latter ordinarily begins to grow over and cover the granulation, so that most surface scars are covered with epithelium.

Healthy granulations are of a bright-pink color and of a velvety appearance. They are very rich in blood vessels, which consist of newly formed capillary loops, and it is on account of these that granulations bleed so freely when injured. Even healthy granulations are continuously bathed in a slight excretion of serum contain-

ing some white cells. The character of the granulation may be modified by either local or general conditions. Local infections, mechanical irritations, a constitutional disease, or general depression, all have a malign effect on the healing process, and it is to one of these that an abnormal or unhealthy condition of granulations is due. A fair estimate of the local or general condition can frequently be gained from the appearance of the granulations.

As granulation tissue matures, it is converted into scar. This is a contractile fibrous tissue, from which eventually most of the blood vessels disappear. As a result of contraction, a normal scar is usually much smaller than the original wound. Owing to its poor blood supply, it is whiter than the surrounding tissue. While scar naturally tends to contract, it cannot do so against any great resistance. It is not a strong tissue, and will stretch when a continuous strain is put on it. This is why, in some situations, scars may increase in breadth and length.

## KELOID

The time after injury at which a scar contracts and the blood vessels are obliterated is somewhat variable, and it may be long delayed. A scar that continues to increase in size and remains red long after the wound has healed is called a keloid scar, which is somewhat different from the true keloid tumor. Some individuals have a distinct tendency to form keloid scars, and sometimes a hint of this condition can be had from observing the scars resulting from former wounds (Fig. 10).

## GENERAL PRINCIPLES OF TREATMENT OF WOUNDS

The first point in the treatment of a recent wound is the *control of hemorrhage*, if this be present. Any but the smallest bleeding vessels are grasped with hemostatic forceps and secured by ligatures. Capillary oozing may be controlled by hot applications or by compression. Bleeding from small vessels in the skin is often arrested by the sutures that bring the edges together.

**Cleansing of the Wound and Control of Sepsis** includes removal of gross particles of dirt, clothing and other foreign bodies, and torn shreds of tissue that is devitalized. The skin edges should be cleansed with soap and water, ether or alcohol, followed by application of tincture of iodin to the wound. The hair in the region should be shaved or cut away.

**Repair of Important Structures.**—In recent wounds all important structures should be repaired. Motor nerves should be united by fine sutures. Injuries to salivary ducts are treated by making provision for the saliva to flow from the cut duct into the mouth (Sali-

Fig. 10.—Keloid scars of face, following burn.

vary Fistula, Chap. XXV. Muscles that are completely divided should be sutured, but it is not always necessary that they be sutured individually.

**Drainage.**—In wounds that are liable to become infected, it is customary to provide drainage to carry off the wound secretions.

This may be done in two ways. If it is a deeper portion of the wound that is to be drained, some substance—as a hollow tube, strands of horsehair, silk or silkworm gut, a folded slip of rubber dam, or some other device—is carried from the point to be drained to the surface, either out through the wound or through an extra stab wound. Drainage from the superficial part of a wound may be accomplished by only loosely approximating the cut surfaces, so that the secretions may exude from between them. Tight suturing not only interferes with drainage of the wound, but, by limiting the blood supply, lessens the tissue resistance. Even where infection of a wound of the face or mouth is well established, unless it is of a virulent, spreading character, union will usually follow suture if drainage is not obstructed.

**Closure of Wounds.**—In dealing with infected wounds of the face and mouth, it may be expedient to wait a few days before suturing. By this time a wall of active granulations has grown in the cut surface, and necrotic parts, possibly with minute foreign bodies, have been thrown off. The factor that is disadvantageous in delayed suture is the contraction that occurs in the developing granulations, which, though it lessens the wound surface, distorts the relations of the cut structures, drawing the skin toward the depth of the wound and causing the retraction of loose flaps.

In fresh wounds, where infection is not expected, the skin or mucous membrane should be accurately sutured. Where no special structures other than muscles are involved in wounds of moderate depth, the deep structures and the skin or mucous membrane may be all united by the same sutures.

Wounds should be closed in such a manner as to exclude dead spaces, in which the tissue fluids and blood may collect. This is an important preventive against sepsis.

If it is seen that suppuration is developing in the depth of a sutured wound, drainage must be established; but on the face and in the mouth it is seldom advisable to recklessly remove all sutures. Preferably, drainage from between the sutures should be encouraged by inserting a pair of pointed forceps into the wound, gently opening them, and removing a suture here and there as necessary. It is only when an infection is of a fulminating character, or when there is a great systemic reaction, that it is necessary to lay the wound open to its full extent. Even then the infection can often be controlled by the use of the ice bag, but in suspected gas bacillus or other virulent infection this should not be attempted.

**Dressings.**—Clean wounds of the face that have been sutured and remain dry often do better without any dressings. Wounds to which drainage has been applied, should be covered with a gauze dressing held in place by adhesive plaster or a bandage. Dressings on clean wounds need not be changed for two or three days, when the wound may be cleansed with alcohol and a fresh dressing applied. Wounds with drainage or packing should be inspected daily, and the drain or packing changed if soaked with pus. Packing in the mouth should never be allowed to remain longer than two days without being changed. Mouth wounds should be kept clean by irrigation every few hours with warm saline or 1-3000 potassium permanganate solution. After removal of packing from a mouth wound and irrigation, the wound may be swabbed with tincture of iodin before replacing the packing. Packing is to be discontinued as soon as the surface of the wound is covered with healthy granulations.

**Removal of Sutures.**—Small superficial sutures, either in the mouth or on the skin should be removed in four to seven days. Deep tension sutures should remain for ten days or even longer if they are not cutting the tissues.

**Carrel-Dakin Treatment.**—The Carrel-Dakin method of sterilizing infected wounds is one of the greatest advances in surgery made during the late war. It consists in the constant flooding of the wound with a solution of sodium hypochlorite of such strength that it will gradually destroy all the bacteria present and at the same time not harm the living tissues. Sodium hypochlorite solutions have long been used for various sanitary purposes, in the form of Labarraque's solution, etc., but never until recently in definitely measured strength and scientifically controlled by bacterial examinations. Dakin, working at Carrel's hospital at Compiègne, showed that sodium hypochlorite solution could be safely used on wounds if the hypochlorite concentration were between 0.4 and 0.5 per cent, and if the alkalinity were reduced below that which gives a red color with phenolphthalein. If the hypochlorite concentration is greater than 0.5 per cent, the solution is too irritating; if less than 0.4 per cent, it is not sufficiently antiseptic. Sodium hypochlorite solutions have a high antiseptic value. They attack and are in turn rapidly decomposed by protein material. In order to maintain effective concentration of the antiseptic, therefore, the solution must be continually renewed. Sodium hypochlorite or Dakin's solution is unstable, and must be prepared fresh before use. It should not be purchased commercially. The method of preparation is complicated, it being usually made from

bleaching powder (calcium hypochlorite) by the action of sodium carbonate, and then brought down to the desired alkalinity by adding dilute hydrochloric acid.

The usual Carrel apparatus consists of a reservoir, a conducting tube, a pinchcock, a distributing tube, and a number of instillation tubes. The reservoir is usually a glass flask having a capacity of 700 to 1000 c.c. The conducting tube is of rubber and leads from the reservoir to the glass distributing tube, which has several openings to which the rubber instillation tubes are attached. Instillation tubes are made of rubber tubing which measures 3 to 4 mm. in diameter. The usual type of instillation tube is ligated at its distal end with linen thread, and is perforated all around for a certain distance from this end with a number of holes 0.5 to 1 mm. in diameter, made with a rubber dam punch. The distal end of the tube is placed in the wound and the fluid admitted intermittently by releasing the pinchcock, i. e., the wound receives a definite amount of fresh solution at regular intervals day and night. It has been found that if this be done every two or three hours, chemical sterilization can be obtained uniformly within a reasonable period of time. When the wound is surgically sterile, instillation should be stopped. In treating wounds according to this method, they should be examined at frequent intervals so that the progress of sterilization can be noted and closure proceeded with at the earliest possible moment. The microscopic smear method of control serves for all practical purposes. This consists essentially of taking a loopful of secretion from the worst part of the wound, smearing it in as even a layer as possible on a glass slide, staining, and determining the average number of organisms per field of the microscope. When there are more than 60 organisms to a field, no attempt is made to count. The wound is sure to be grossly infected. Experience has shown that a wound can be safely closed when the average is one organism in five fields. The counts are recorded on a special chart, a curve being thus established representing graphically the progress of sterilization of the wound.

There are many difficulties connected with the application of Dakin-Carrel treatment in wounds about the jaws. In the first place, many of these wounds are in communication with the mouth cavity and are continually bathed in saliva and being reinfected with the bacteria from the mouth. This factor practically neutralizes any antiseptic action of the Dakin's solution. Even where there is no communication between the mouth and the wound, the mechanical difficulties of keeping the tubes in place and in connection with the irrigating

apparatus are great owing to motion of the patient's head. On the other hand, it is sometimes possible to apply Dakin's solution to great advantage in this region. A Carrel tube is selected in which the perforations extend for not more than one inch or an inch and a half from the end of the tube so that none of them will be outside the wound. The tube is inserted to the full depth of the wound and the surrounding skin protected from irritation by covering it with vaseline gauze. The other end of the tube is allowed to project outside the dressings, and about half an ounce of Dakin's solution is slowly injected into the tube every three hours with a glass syringe. The wound is redressed and the tube replaced every forty-eight hours or oftener if necessary.

Chemical sterilization of superficial granulating wounds may be brought about by the application of dichloramin-T. This is another chlorine preparation, more stable than Dakin's solution, insoluble in water, but soluble in oil saturated with chlorine. It is manufactured by several reliable concerns, and need not be prepared immediately before use if properly kept.

## BURNS

Burns are really a variety of open wounds. Deep burns contain a foreign body—the burnt tissue. Burns are classified according to the depth to which the tissue is destroyed. The disfigurement resulting from a burn is dependent on the depth and extent, and also on the amount of infection that followed. The heavy scarring often seen after a severe burn is the result of an excessive inflammatory process, due to a prolonged infection. Superficial burns, though less destructive, are more painful than deep ones. The pain should be controlled, which may be done more or less effectually by cold, moist applications or, better still, on the skin surface by the application of a saturated solution of picric acid in water, applied with cloths for several hours. The picric acid solution will relieve the pain almost instantly, but the disadvantage is of staining the skin yellow. With extensive burns, shock is often a serious complication (Treatment of Shock, page 105).

A burn is an aseptic wound, and its aseptic character should be preserved. It is not always possible to do this with dry dressing, as infections may occur at the junction of the skin and the slough. The skin always contains the organisms of sepsis. The application of a pack of alcohol or of a 5 per cent colloidal silver is nonirritating and nontoxic, and will render the eschar antiseptic.

Lately the old idea of applying oil as a protective dressing has been superseded by the application of a film of paraffin to the burn.[1] The surface of the wound is cleaned and dried—this latter may be accomplished by applying first alcohol and then acetone—and then a coating of liquid petrolatum is applied with a brush or a spray. This is followed by a thin layer of cotton which is saturated with the hot wax. A gauze dressing and bandage complete the dressing after the wax has hardened. This dressing is repeated daily after cleaning and drying the surface of the burn. It is claimed that by this form of treatment relief from pain is immediate and healing is rapid.

If the full thickness of the skin, with its glands, has been destroyed, the resulting defect should be remedied by skin grafting or by flap operation.

The pain of slight scalds of the mouth is partially relieved by alkaline antiseptic washes and cold applications. As a rule, they need little other treatment. Severe scalds of the mouth or pharynx, such as occur with children and insane people, are very serious, and liable to be fatal from edema of the glottis. The acute swelling in the mouth is to be relieved by the application of ice, or incisions, especially into the dorsum of the tongue, and tracheotomy should be done if edema of the glottis threatens.

In burns that result from chemical caustics, the chemical agent remaining in the wound should be neutralized, and then the injury should be treated on general lines. Carbolic acid is neutralized by alcohol or whiskey, lye by vinegar and oils (fine olive oil does not saponify readily), and all acids by an alkali, usually the bicarbonate of soda, preferably in solution.

X-ray burns, which occasionally appear after prolonged or repeated exposure to the ray, or from exposure to radium salts, present a peculiar phenomenon, varying from a redness or a pigmentation of the skin to deep ulcers. The first form needs no special treatment. The ulcers are very indolent, and may require from one to two years to heal if left to themselves, and the scars are liable to be the seat of carcinoma. The best form of treatment for severe burns seems to be the removal of necrotic tissue and granulations, and the application of thick grafts or flaps transferred from neighboring healthy tissue. According to F. C. Wood, even if such flap grafts slough, they sometimes leave the tissue in such a healthy condition that Thiersch grafts will then grow satisfactorily.

[1]Sollman, who has studied this method, states that a simple paraffin melting at or below 50° C., is superior or equal to the complex mixtures that have been advocated.

## CHAPTER VIII

## SURGICAL TECHNIC

### ASEPSIS AND ANTISEPSIS

By *asepsis* is meant absence of sepsis, that is, freedom from bacteria, or sterility.

By *antisepsis* is meant the measures used to combat sepsis or the presence of bacteria, with the object of attaining a state of asepsis. An *antiseptic* is a chemical agent capable of restraining the growth of bacteria.

Surgical operations should be performed as far as possible under aseptic conditions. To this end, bacteria are removed from the surface of the field of operation, and kept from it during and after the operation by allowing only sterile objects to come in contact with the field—dressings, instruments, solutions, and operator's hands. In external operations on the face and neck, this can be successfully observed for the most part, but within the mouth asepsis is difficult and impossible in many types of operation.

The object of these preparations is to reduce to a minimum the amount of septic material that may be introduced into a wound. Surgery cannot be done under the circumstances that test tube experiments in the bacteriologic laboratory might lead one to deem essential, but fortunately for the practicability of our art and for the preservation of the race, there is a natural resistance on the part of the tissues that will usually overcome any moderate bacterial invasion. We are often somewhat prone to forget what we owe to tissue resistance.

**Preparation of the Surgeon's Hands, etc.**—All that is demanded for dental work and mouth examination is ordinary personal cleanliness, but the hands should be cleansed in the presence of the patient before each examination or operation. When bone or soft tissues are to be invaded, then what is regarded as surgical cleanliness is to be adopted. This differs from the former in degree—not kind. It is absolutely impossible to free the skin from all bacteria, but their number can be greatly reduced.

It is customary for the surgeon and assistants to wear a special

operating suit made of washable material, and a head cap and face mask to guard against contamination of the wound by saliva and sweat. To clean the hands for an operation, the nails should be trimmed short enough so that they can be cleaned with a brush. The hands and forearms to above the elbows are scrubbed with a brush or wash cloth in hot water and soap for five minutes. The mechanical scrubbing is the important part of hand preparation. It is customary to immerse the hands subsequently for a few moments in some antiseptic solution. It makes little difference what is used if it causes no irritation of the skin. Ninety-five per cent alcohol used for five minutes will destroy most of the surface bacteria, and has several advantages over the aqueous antiseptic solutions. A sterile gown with long sleeves is then put on over the suit, and sterile rubber gloves are worn. The gloves should be free from minute holes, and should be changed if punctured during the operation. The perspiration that collects within a glove is usually germ-laden. After this preparation, the surgeon or assistant must under no circumstances touch, or allow any part of his person to be touched by, anything that is not sterile. While waiting for the operation to begin, the surgeon may wrap his gloved hands in a sterile towel.

**Preparation of the Operative Field.**—Within the mouth little more can be done than the removal of gross sources of sepsis and repeated washing with a nonirritating fluid, such as 1-2000 potassium permanganate solution. Just before making the incision the mucous membrane may be painted with tincture of iodin.

In preparation of the skin, all hair in the operative field should be shaved several hours before the operation, and the skin well scrubbed with soap and water. Dirt and scales of skin are removed with benzin. Just before the operation, the skin is painted with a three and a half per cent tincture of iodin. After the coating of iodin has dried, it may be washed off with alcohol to avoid blistering. Another very efficient application for skin sterilization is ten per cent picric acid in alcohol, which is less irritating than iodin. The chief objection to its use about the face is the yellow discoloration which remains for some days. After this preparation, nothing that is not sterile must come in contact with the operative field. Sterile sheets and towels are draped about the skin, and secured by special clips. In operations about the face and neck, sterile towels are placed around the head, covering the hair, and also over the mouth if possible, the anesthetic in these cases being given intrapharyngeally through nasal or oral tubes.

**Sterilization of Instruments and Various Materials used in Operations.**—The various instruments, materials, etc., used in surgery, require different methods of sterilization, according to their composition. Sterilization by heat is more efficient than sterilization by chemicals, and should be used when possible. The usual methods available are by boiling, by subjecting to superheated steam, and to hot air under pressure. Chemicals, such as phenol, are sometimes used for the sterilization of delicate cutting instruments, whose sharp edges would be damaged by heat.

**Sterilization by Boiling** is the most efficient method for instruments and all objects that are not damaged by water. It is an almost universal custom to sterilize instruments by boiling them from ten to twenty minutes in plain water. This will kill nearly all pathogenic bacteria, but will not always kill spores. The spores of anthrax and tetanus will resist boiling water for long periods, but it is probably very seldom that these are present. Boiling for twenty minutes is injurious to the edges of fine-cutting instruments, and these should always be sharp. It is therefore customary in these cases to resort to some form of chemical sterilization. A good plan is, after thoroughly cleansing them, to place the knives in 95 per cent phenol, immersing them in alcohol immediately before use. Other materials that may be sterilized by boiling are silk, silkworm gut and horsehair sutures, and rubber tubing.

*Steam under pressure or hot air* is used for sterilizing towels, sheets, gowns, gauze and cotton dressings, bandages, packing, rubber gloves, catgut and anything that would be damaged by contact with water. Linen and cotton materials are first wrapped up in muslin covers, so that they can be maintained in a sterile condition until they are needed. After sterilizing towels, etc., by steam, the steam is driven off and hot air admitted so that the materials will be thoroughly dried. Moist heat is a much more efficacious germicide than dry heat, and destroys microorganisms at a lower temperature. Subjecting to steam under fifteen pounds pressure for ten to fifteen minutes gives absolute sterilization.

For operations about the face and mouth, besides the instruments, the following articles should be put up in packages and sterilized:

(1) Operating gowns. (2) Sheets to cover patient. (3) Towels, in packages of six, for drying the sterile hands of the operator and for draping about the field of operation. (4) Small gauze pads for wiping away blood, saliva, etc. (5) Small cotton sponges. (6) Larger gauze pads, about six inches square and about eight thick-

nesses of gauze, for dressing the wound after the operation. (7) Wooden applicators, mounted with cotton at each end, to be used as swabs, for applying iodin, etc. These are put up in packages of one dozen. They are mounted with cotton at each end for economy and for convenience in applying iodin to mucous membranes, one end being used to dry the surface and the other for the iodin. (8) Rubber gloves. Rubber gloves may be sterilized by the dry method, or, more easily, by boiling, being put on wet. (9) Gauze packing, plain and iodoform, in narrow strips, ¼ to 1 inch wide.

Other things required are: Pans for solutions—such as sterile water, normal saline, alcohol, bichloride of mercury, etc.: glasses and vials for iodin, and for local anesthetic solution; trays for instruments; suture materials, including catgut, silkworm gut, silk, horsehair, and sometimes silver wire.

A *suture* is a stitch used to bring severed tissues together. Suture materials are absorbable or non-absorbable by the tissues. *Catgut*, prepared from the intestine of the sheep, is absorbable, and is therefore used for uniting deep tissues, such as fascia, which are not exposed after the wound is closed. Catgut comes in different sizes. Nos. 00, 0, and 1 are most generally employed. In the case of deep sutures, it is sometimes advisable that absorption be delayed for some time, in order to hold the tissues together until complete healing has occurred. This delayed absorption may be brought about by subjecting catgut to the action of chromic acid. Chromicized catgut will resist absorption for 20 days or longer. Catgut requires special processes of preparation and sterilization. It is usually put up in glass tubes, all ready sterilized for use.

For closing skin wounds, silkworm gut, silk and horsehair are generally used. *Silkworm gut* is prepared by drawing out the silk secretion of the silkworm in one piece without weaving. It is very tough, can be sterilized by boiling, and is used especially where considerable tension is necessary to bring the edges of the wound together. *Silk* is especially adapted to suturing wounds of mucous membranes, as it is soft and non-irritating. It is sterilized by boiling. *Horsehair* is good for fine sutures of skin or mucous membrane, where little tension is required. It is sterilized by boiling. *Dermal suture*, a Japanese silk preparation, is more flexible than silkworm gut and at the same time is stronger than horsehair. It is sterilized by boiling. It is very well adapted for fine skin and mucous membrane sutures. *Silver wire* is sometimes used for suturing fragments of bone. Cat-

gut is absorbable. All the other suture materials mentioned are non-absorbable, and must be removed after several days.

There are various methods of applying sutures. A *continuous* suture is a running stitch that unites the wound edges from one end to the other. It is especially used for deep tissues, such as fascia, though sometimes also for the skin.

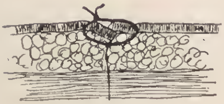


Fig. 11.

Fig. 12.

Fig. 13.

Fig. 14.

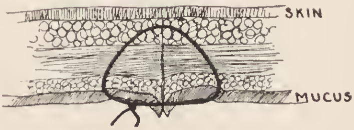



Fig. 15.

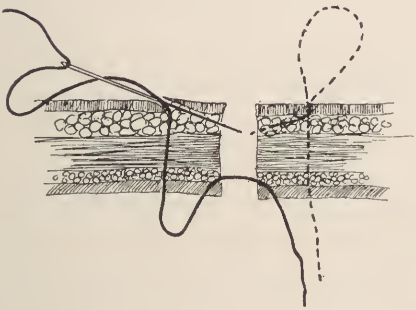


Fig. 16.

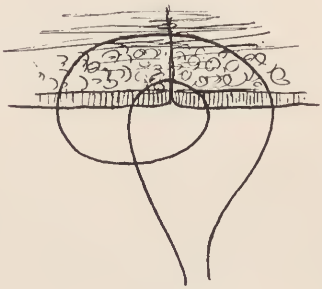


Fig. 17.

Fig. 11.—Suture that causes skin edges to lap.

Fig. 12.—A suture that penetrates too deep in comparison to its lateral extent may cause a depression at the wound edge.

Fig. 13.—A properly placed suture.

Fig. 14.—Illustrating how each suture should cross the wound at right angles.

Fig. 15.—A deep suture suitable for a mucous surface that will not allow the mucous borders to overlap.

Fig. 16.—A modification of the deep stay suture that Lane uses in the lip. This is tied on the mucous surface.

Fig. 17.—A suture that approximates the deep and superficial tissues. This suture must be drawn loosely, or the tissue within the grasp of the short loop of the suture is apt to slough.

An *interrupted* suture is made up of separate stitches. On the face and in the mouth interrupted sutures are in most instances preferable to continuous sutures. On the face, the sutures that unite the skin edges should not be depended upon to overcome tension. Where there is any resistance to the approximation of the wound edges, it

should be overcome by retention sutures. In placing interrupted cutaneous sutures, there should be a relation between the depth to which each suture penetrates into the tissue and its width. Suture that embraces a large skin area and does not penetrate any depth into the tissue may cause the skin margins to overlap one another (Figs. 11 and 12). It is not necessary, however, that the greatest width of the suture should be on the skin surface (Fig. 13). Again, there should be a proportion between the width and depth of the sutures and their distance from each other. As a rule, sutures should penetrate to a depth equal to one-half of the width, and they should not be placed closer together than necessary. If the tissues are held in place by a stay suture, fewer skin sutures will be required. Each suture should cross the wound at right angles (Fig. 14). Several plans of stay sutures are shown in Figs. 15 to 17. Through and through stay sutures that cross the skin and mucous surfaces, cause scars, which, though they may ultimately become invisible, certainly detract very much from an immediate good result.

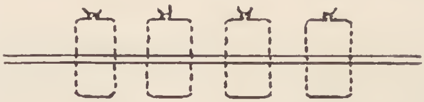


Fig. 18.—Interrupted mattress sutures.

A mattress suture (Fig. 18) is useful in bringing broad raw surfaces together from the sides of the wound. An ordinary stitch is first taken through each edge of the wound. The needle is then reinserted at a point further along the edge and brought out on the other side at a corresponding distance from the point of original insertion. The mattress suture is useful after excision of depressed scars, as it tends to raise the edges of the wound and prevent recontraction with healing.

Skin sutures should be removed after four to seven days. Tension sutures sometimes remain for ten days or longer.

## LIGATURES

A ligature is a thread used to tie a blood vessel or to constrict a morbid growth. Ligatures are most commonly used to prevent hemorrhage by tying off blood vessels that have been severed or that are about to be severed. Ordinarily ligatures are of plain catgut, 00, 0, or 1 in size. In the case of very large vessels, where there might

be some danger of recurrence of hemorrhage after absorption of the ligature, chromicized catgut or silk may be used. It is generally necessary to tie both ends of a large severed vessel. Square knots and not "granny" knots should be used for tying ligatures and sutures (Figs. 19 and 20). To prevent slipping the **surgical knot** is often used. This consists of a double turn in the first knot, instead of only one (Fig. 21).

Fig. 19.—Square or reef knot.

Fig. 20.—"Granny" knot.

Fig. 21.—Surgical knot.

## INSTRUMENTS

The following are the instruments commonly employed in surgical operations. Many special instruments have been devised for special operations:

**Scalpel or Knife.**—The size of the blade should be adapted to the type of operation. If a long incision is necessary, a large broad blade is used. For delicate plastic operations, knives with very fine blades are employed. The primary requisite for knives is that they must be sharp.

**Scissors** are used for cutting sutures, ligatures, dressings, and for dissecting and trimming tissues. They may be curved or straight, and of various shapes and sizes.

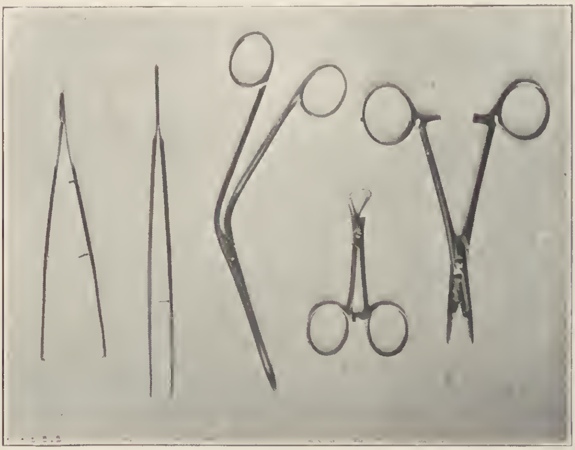
A **grooved director** is a probe-like instrument used for exploring wounds, sinuses, etc. It has a groove to guide the knife in making incisions.

**Probes,** generally made of silver, come in various lengths and

diameters. They are flexible, and usually blunt at the end, to avoid damage to deep structures.

*a* *b* *c* *d*

Fig. 22.—(*a*) Smooth lip retractor; (*b, c*) blunt hooked retractors; (*d*) blunt dissector or periosteal elevator.

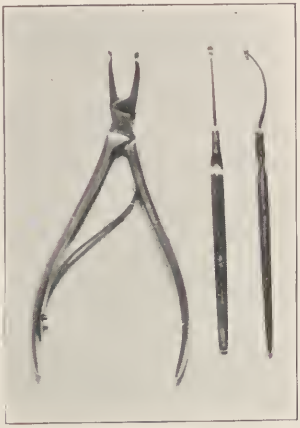


*a* *b* *c* *d* *e*

Fig. 23.—(*a*) Mouse-tooth tissue forceps; (*b*), dental pliers; (*c*), nasal dressing forceps; (*d*), towel clamp; (*e*), combination needle holder and suture scissors.

**Retractors** are used to separate the edges of the wound in order to expose the deeper parts. They may be plain or have blunt or sharp hooks (Fig. 22). Care must be exercised in using hooked

retractors not to wound or tear important structures. For the lips, smooth retractors only should be employed (Fig. 22). Various self-retaining retractors have been devised, and for the lips may be connected to a head-band.



*a* *b* *c*

Fig. 24.—(*a*), Rongeur forceps; (*b*, c), periapical curettes.

*a* *b*

Fig. 25.—(*a*) Ear and ulcer syringe; (*b*) Chip blower syringe.

**Tissue forceps** are used to catch the skin or deeper tissues to steady them while incisions and dissections are being made. They may have plain smooth points, or be of the mouse-toothed variety (Fig. 23). The latter form is more useful, as a firmer hold may be had on the tissues.

**Blunt Dissector** is an instrument with a dull blade, used in separating the tissues. By its use, danger of dividing important structures, such as blood vessels, is minimized. Blunt dissectors come in various shapes and sizes (Fig. 22).

**Allis forceps** are very useful toothed forceps, locking like hemostatic forceps, for grasping tissues, holding back flaps, etc.

**Hemostatic forceps** are instruments used to clamp blood vessels to arrest hemorrhage. In the case of small vessels, the clamp may be removed after a short time. With larger vessels, a ligature must be applied before removal of the clamp. Hemostatic forceps come

Fig. 26.—Mouth gags.

in various shapes and sizes, straight and curved. A small delicate form is known as mosquito forceps.

**Chisels.**—In bone operations, chisels and gouges of various sizes and shapes are used. Some are designed for operation with the mallet, while others have large handles for hand pressure.

**Bone-cutting and rongeur forceps** are used for trimming off uneven and overhanging edges of bone. The rongeur forceps shown in Fig. 24 are useful for trimming off the alveolar process.

**Curettes** are instruments designed to scrape out infected cavities in bone and sinuses in the soft tissues. They come in many sizes and shapes. For small areas of infected bone about the roots of teeth, the modified chalazion curettes shown in Fig. 24 are useful.

**Sequestrum forceps** have long serrated beaks, and are used for removing loose pieces of dead bone. For grasping small fragments of bone, inserting packing, etc., the forceps shown in Fig. 23c are very useful.

**Irrigating syringes,** for washing out pus, etc., from cavities may be made of glass, metal, or rubber. For washing out the mouth, the ordinary dental chip blower is very adaptable (Fig. 25*b*). Another very convenient form of syringe is the little rubber ear and ulcer syringe (Fig. 25*a*).

**Needles** may be curved or straight, and may or may not have cutting edges. For the skin and mucous membrane, cutting edge needles are used. The size of the needle employed depends on the size of the suture. In plastic work, very fine, curved cutting edge needles are employed. The curve may vary according to the case.

**Needle holders** come in various forms. Probably the most convenient, when a small needle is used, is the ordinary hemostatic forceps.

**Mouth Gags.**—For operations within the mouth, various forms of mouth gags have been devised. Some of these are illustrated in Fig. 26.

An **electric headlight** is a valuable adjunct in operations about the mouth, where it is difficult to throw the ordinary light.

## DRAINAGE MATERIALS

Drainage in a wound is indicated if suppuration is present or if it is expected that there will be some oozing of blood. Strips of plain or iodoform gauze, of various widths, rubber tubing, rubber dam, or strands of silkworm gut may be used for drainage. If **gauze** be used, it should be placed loosely in the wound, otherwise it will form a plug rather than a drain. In any case it must be changed frequently or it will not serve the intended purpose. **Rubber tubing** of various sizes is very useful for drainage where a large incision is present. Small holes are cut at intervals along the tube, the end of which is inserted to the bottom of the wound. Sometimes two incisions are made, and a piece of rubber tubing passed from one incision to the other, the pus entering the tube through the lateral openings. This is known as through and through drainage. The tube may be used as a means of irrigating the wound. For small openings, a strip of **rubber dam** may be used to keep up drainage. The pus will escape along the side of the rubber dam. Sometimes a

few strands of **silkworm gut** are twisted together and placed in the wound, with the ends projecting. Any oozing that occurs will escape alongside the silkworm gut.

**Packing** is employed in the form of strips of plain or iodoform gauze. It is indicated for the control of capillary hemorrhage, and for promoting granulation of a cavity in bone or soft tissues by keeping the walls of the cavity apart and absorbing secretion. Packing should usually be inserted firmly, though not too tightly.

**Dressings** consist of pads made of several layers of sterile gauze. The dressing is held in place with strips of adhesive plaster, and over all a bandage may be applied. After plastic operations on the face, it is often unnecessary to apply any dressing. Dressings about the face are apt to absorb oral or nasal secretions and thus lead to contamination of the wound.

**Bandages.**—Bandages are made of muslin or of gauze. Gauze is, as a rule, satisfactory for holding ordinary dressings in place, but where considerable support and firmness are required, as in the case of fractures, the muslin bandage is preferable.

For holding dressings on the face and jaws, a modification of the Barton bandage is very convenient (Fig. 86). Here muslin or gauze two inches in width is used, and is applied in the following manner: Starting at the occiput, the bandage is carried to the vertex, then beneath the chin, to the vertex, to the occiput, under the chin, to the vertex, ending at the occiput. This modification avoids backward pull on the chin.

## CHAPTER IX

## INJURIES OF THE TEETH AND ALVEOLAR PROCESS. PLANTATION OF TEETH

### LOOSENING OR AVULSION OF THE TEETH

In the process of separating the teeth, or in orthodontic procedures, too much strain may be brought on a tooth, and as a consequence, its pulp may die. As a result of violence, a tooth may become loosened in its socket or entirely avulsed.

**Treatment.**—A tooth which is simply loosened without fracture of the alveolar process will usually regain its normal solidity without treatment. A tooth that has been forced from its normal position, but which has not entirely left its alveolar socket, is called a displaced tooth. It should be replaced in its normal position, and held there by silk or wire ligatures, or metal bands, attached to the neighboring teeth, until it has become solid.

A tooth that has left its socket may sometimes be replaced. (Replantation.)

### FRACTURE OF THE TEETH

As a result of violence, a tooth may suffer injury, varying from slight chipping of the enamel to a fracture of the body of the crown, or of the root (Fig. 27). Decay may so weaken a crown, without

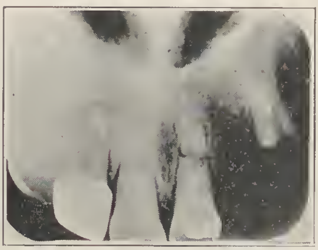


Fig. 27.—Radiogram showing fractured central incisor roots.

necessarily destroying all of its enamel, that it may readily fracture on very slight pressure. Nature has not, except by the deposition of secondary dentin, made provisions for repair of the teeth,

and therefore lost tooth structure must be replaced mechanically by the dentist if the normal outline of the teeth is to be restored.

**Treatment.**—If the crown of a tooth is fractured, it may be replaced with an artificial substitute; if the root is fractured, an attempt may be made in some cases to save it by banding. Callous union may occur if the pulp recovers. In the majority of cases of fracture of the root, extraction of the tooth is necessary.

## FRACTURE OF THE ALVEOLAR PROCESS

Fractures of the alveolar process that are not associated with fracture of the body of the jaw are usually secondary to the displacement or extraction of one or several teeth. The fracture may involve a large section of the process and carry with it several teeth, or it may be splintered in the neighborhood of one tooth.

**Treatment.**—All fragments of the alveolus attached to the soft tissues should be replaced. If there are teeth in the fragment, these should be fixed to neighboring solid teeth. All detached fragments should be removed, as they will be ultimately thrown off, and until removed, are a source of irritation.

## PLANTATION OF TEETH

Plantation of teeth includes three distinct procedures, transplantation, replantation and implantation. While instances have been recorded in which teeth have been retained and done good service for many years after the performance of these operations, yet in the light of recent knowledge of chronic inflammatory processes about the roots of teeth and their relation to general systemic infections, it is believed that such procedures, particularly implantation and transplantation, are rarely indicated or justifiable. At the same time, exceptional conditions may arise, where one of these operations may be advisable.

By *replantation* is meant the reinsertion of a tooth in the socket from which it has been removed purposely or by accident, Replantation may occasionally be warranted under the following conditions:

(a) When a tooth has been dislodged by traumatism or accidentally removed in the performance of a dental extraction or other operation.

(b) In the case of a tooth which is the seat of chronic periapical disease. If a tooth has been completely removed from its socket by

trauma, conditions for its reattachment are not so favorable as in the case of partial dislocation. Nevertheless, an attempt should be made to retain the tooth by replantation. If the root has not been fractured, the tooth should be cleansed of all foreign matter and placed in an antiseptic solution, such as bichloride of mercury 1-2000. The pulp chamber should be opened, the pulp removed, and the canal filled. In order to completely reinsert the root in its socket, it may be necessary to remove the apical third of the root. Before replantation and after the root operation, the tooth should again be placed in the bichloride solution for at least half an hour. Before replantation the socket should be thoroughly cleansed and swabbed out with a germicidal solution, such as Talbot's iodine. A splint should have been prepared, in order to provide immobility for several weeks.

The removal and replantation of teeth after removal of the necrotic root end as a cure for periapical disease is a questionable practice, and should rarely be resorted to.

By *transplantation* is meant the insertion of a natural tooth into the socket of a recently extracted tooth. The tooth inserted may be an old and dry tooth which has been extracted for a long time, or it may be a freshly extracted tooth from another part of the mouth of the same individual, or it may be a freshly extracted tooth from another individual. Transplantation is practically never practiced at the present time. The only possible indication would be where a healthy tooth has been lost through accident.

By *implantation* is meant the insertion of a natural or an artificial tooth into a new socket. This operation has been largely given up, as the results are so rarely successful that the trouble is not justified. The originator of this operation is Dr. Younger, of San Francisco, who first performed it in 1889. Younger drilled a socket for reception of the root in the alveolar process with a trephine, enlarging it to the proper shape with reamers and burs. Several years ago, Greenfield advocated making a trephine groove in the process for the reception of a tubular artificial root of platinum, upon which was mounted a porcelain crown. For a time remarkable results were claimed for this operation, but practically no lasting successes were achieved, and the procedure fell into disrepute. The exposure of the foreign body acting as the root to the oral secretions resulted in absorption of the surrounding alveolar process with loosening and loss of the tooth.

# CHAPTER X

# FRACTURES

**Definition.**—A fracture is a solution in the continuity of a bone.

**Causes.**—The causes of fracture are *predisposing and exciting.*

Predisposing causes are:

(1) Certain *general bone diseases* which either cause a softening or a brittleness of the bones. The commonest are rickets, osteomalacia, and fragilitas ossium.

(2) *Local bone diseases* are tumors of the bone, such as sarcoma and carcinoma, cysts, and osteomyelitis. In bones which are the seat of extensive disease, the amount of trauma required to produce fracture may be very slight.

The exciting cause of fracture is *trauma* or violence. Violence may be, (a) direct, when the fracture occurs at the point of application of the trauma, (b) indirect, where the fracture occurs at a point distant from the injury, (c) muscular, when the fracture occurs due to sudden contraction of one of the muscles attached to the bone.

## VARIETIES OF FRACTURE

1. A *greenstick* fracture is an incomplete fracture, occurring in the incompletely calcified bones of young children, in which some of the fibers bend instead of breaking, like a green stick of wood.

2. A *simple* or *closed* fracture is one in which there is no communication between the outer surface and the site of injury to the bone.

3. A *compound* or *open* fracture is one in which there is a communication between the outside skin or mucous membrane and the site of fracture through a wound. The main reason for distinguishing between simple and compound fractures is that the latter are more susceptible to infection from without.

4. A *comminuted* fracture is one in which the bone is shattered into several fragments.

5. An *impacted* fracture is one in which one fragment is driven into the other and fixed there.

6. A *depressed* fracture is one in which a flat bone is driven in on to the underlying tissues.

## SYMPTOMS AND SIGNS OF FRACTURE

These are:

(1) *Pain.* Pain is usually severe, and aggravated by the slightest movement of the injured part. Pain is felt at the site of the fracture when another part of the bone is handled.

(2) *Disability* is an obvious result of fracture, and varies according to what bone is injured.

(3) *Swelling,* due to effusion of blood and serum from torn vessels and inflammatory reaction.

(4) *Tenderness,* or pain on pressure at the point of injury to the bone.

(5) *Discoloration* of the skin, as the effused blood reaches the surface. If the fracture occurs in a deep seated portion of the bone, discoloration of the skin may not appear for several days.

(6) *Deformity* is usually present in cases of fracture, and is due primarily to the direction and strength of the force producing the fracture, and secondarily to contraction of muscles attached to the fragments. Gravity may also play a part in the deformity.

(7) *Abnormal mobility* at the site of fracture is one of the most distinctive signs.

(8) *Crepitus* is a feeling of grating, transmitted to the examining hand, when the fractured surfaces rub against one another. It is pathognomonic of fracture, but if the diagnosis can be made without it, painful manipulation should be avoided:

Attention to these clinical signs and symptoms will usually enable a diagnosis of fracture to be made with certainty, but these should always be confirmed by the x-ray.

## TREATMENT OF FRACTURES

The general principles of treatment of fractures are:

(1) Reduction of the fracture, i.e., to get the fractured surfaces in good position.

(2) Fixation of the fragments in proper position until union occurs. To these should be added, (3) care of the tissues.

## FRACTURES OF THE UPPER JAW

As has been pointed out by Cryer, the maxillary bones include, surgically, the malar, the palate, the inferior turbinate, the lachrymal, the nasal, and the lateral masses of the ethmoid and the nasal septum, as

any or all of them are liable to be involved in injuries characterized as fractures of the maxillary bones.

The nasal bones, with or without involvement of the septum, are more often fractured than any of the others, and most commonly without injury of the other bones. Either of the malar bones, with their zygomatic processes, may be fractured or displaced without extensive injury to neighboring bone structures.

## Character of the Injury

Fractures of the maxillary bones may vary in extent from injuries to the alveolar process to a tearing loose of all of the facial bones by a transverse fracture at or near their attachment to the cranium, the latter being often associated with extensive fractures of the brain case and brain injury. The prominence of the cheek bone usually receives the force that causes such extensive injuries, and it is not uncommon to find that the malar bone and the body of the maxilla of that side are crushed.

In the late war all varieties of gunshot and shell injuries were encountered from more or less clean through-and-through shots to tearing out of great masses of bone and flesh.

**Displacement.**—The displacement is always due to the original violence or to gravity. The hard palate may be pushed upward until it infringes on the nasal fossa, and displacement of the alveolar process will vary with the direction of the force. Extensive fractures of the maxillæ, involving other facial bones, without loss of substance, may be divided into two classes according to the character of the predominant displacement: (1) if a severe force is applied from in front in an upward and backward direction, such as the kick of a horse, the maxillæ may be driven in toward the base of the cranium with considerable comminution and impaction; or (2), if, as is most commonly the case, the force is applied to the prominence of the cheek, the malar bone will be more or less driven into the maxillary antrum, but at the same time there may be extensive radiating fractures. If one of these is a transverse fracture through the orbits, the whole bony framework of the face may sag down, supported only by the soft tissues.

In certain shell injuries the soft tissues may be so extensively cut as to render but a partial support. It is with the transverse facial fractures that basal fractures are most liable to occur. In some instances, by taking hold of the upper teeth, the whole face

can be made to move on the cranium, and we have seen the skin at the root of the nose puff out and in with each respiration, while the pulsations of the brain were plainly visible, transmitted to the skin through crevices in the vault.

**Diagnosis.**—There can be no difficulty in diagnosing fractures with displacement which extend into the alveolar process. Slight depressions or displacement of the malar bones might be overlooked on casual inspection, and if there is much swelling, it may be impossible to detect the displacement by palpation. In all cases of injury of the face the dental arches and the palate should be inspected, and the facial bones outlined digitally. This is best done by standing behind the patient, and with the thumb and fingers of both hands examining simultaneously the orbital borders and the intraoral and extraoral outlines of the malar, maxillary, and nasal bones, and of the zygomatic arches. A definite local tenderness that can be elicited by pressure made on a distant point or points, the force being transmitted through the bone, is always suggestive of a fracture at the tender point. Slight lateral deviation of the nasal bones may be detected by making a pencil mark in the center of the bony ridge, and then viewing it from above while standing behind the patient. The swelling that obscures the diagnosis may be modified by cold applications or by digital pressure under an anesthetic. Where available, an x-ray negative may in some cases settle the question.

## Treatment

As with fracture of the mandible, treatment consists both in the care of the tissues and in the mechanical treatment of the fracture. These fractures are often accompanied by very severe shock, and may be but part of an injury that involves concussion or laceration of the brain or intracranial hemorrhage. Emphysema of the cellular tissue of the face is not an uncommon complication of fractures involving the nasal fossa or maxillary antrum. There may be considerable swelling, and if the patient is not seen until some hours after the injury has occurred, this can obscure the exact nature of the fracture and of itself cause obstruction of the nasal passages.

Even in simple fracture any of the structures contained in the face may be injured—more particularly the maxillary division of the fifth nerve, the branches of the internal maxillary artery, and the lachrymal duct. Sepsis may follow, as these fractures, extending into the antrum or nasal fossa, are usually open.

In gunshot or shell injuries any amount of tissue may be torn away or a sharp fragment may cut deeply, leaving a part of the face sagging with a wide exposure of the deeper structure cavities.

In caring for a simple fracture itself, the surgeon usually does all that is necessary when he restores and retains the bones in their proper relations and keeps the involved cavities as free as possible from material that would promote sepsis.

In the more extensive open fractures, and in cases of great loss of tissue, not only must the remaining bones be placed as nearly as possible in their normal position, but the treatment of the open wound must be instituted.

**Care of the Tissues.**—Often the care of the patient is of greater importance. Emphysema is best combated by insuring free egress of air through the nose or mouth. In rapidly extending emphysema we have plugged the posterior nares, and the effect was beneficial. Cold, in the form of an ice bag, is the most efficient means of preventing or treating the swelling due to the infiltration of the tissues with serum. The cold should be so applied as to cool, but not freeze, the tissues. If, owing to swelling, breathing is labored, it can be partially relieved by dropping a solution of adrenalin chlorid into the nostrils. Until proper fixation is applied, breathing can sometimes be facilitated by placing in the mouth a large rubber tube that extends back to the oral pharynx. Injury to the maxillary nerve may be evidenced by an anesthesia over the area of distribution, or later by a neuralgia, but it is not common. Hemorrhage, though it may be sharp at first, is in simple fractures usually self-limited. Obstruction of the nasal duct that is not relieved with the subsidence of the swelling would need special attention later.

Sepsis is to be combated by frequent irrigation of the nasal and oral cavities, and if the maxillary antrum is widely open, this should receive the same treatment. If the antrum contains an infected blood clot, it should be opened and cleansed. In douching the nasal cavity, the patient should, if possible, be in a sitting or semierect position, and no forceful stream should be used. If the lower portion of the nasal fossa is kept clear, the discharge from its upper part will flow down and not collect. It should be remembered that when fluids are forced to the upper part of the nasal fossa there is danger of infection of the accessory sinuses. In these simple fractures the most serious complication is a fracture of the base of the cranium, which, besides being often accompanied by brain injury that may be of itself fatal, leaves an open avenue to intracranial infection. In all severe

cases, hexamethylene tetramine may be administered in fairly large doses in an attempt to render the mucus and the cerebrospinal fluid antiseptic. Under no circumstances should any considerable quantity of attached bone be removed. The bones connected with the maxilla are well nourished, and, unless absolutely detached, will usually unite if replaced, while the loss of even small pieces will leave noticeable deformity. This holds true particularly in cases where the whole face is crumpled up by some severe blow in front, such as the kick of a horse or the passage of a shell fragment.

**Mechanical Treatment of the Fracture.**—For treatment of fractures of the alveolar process see Injuries of the Teeth and Alveolar Process, page 136.

Injury to the palatal process is rare, and is due as a rule to a gunshot wound that will not need mechanical fixation.

Impactions must be carefully diagnosed, and the bones restored to their normal outline. For this purpose the antrum may be opened from the mouth above the canine fossa, and the bones pried outward or downward with a steel urethral sound. The malar bones, the zygomatic process, and the lower border of the orbit can be manipulated into place with least disfigurement by inserting a strong, sharp, steel hook or a towel clamp through the tissues to engage on the various edges of the bones. If the impaction cannot be broken up in this way, resort may be had to a small, sharp chisel. Unless the bones are terribly shattered, there is little tendency for the deformity to recur. If there is this tendency, the bones can be wired in appropriate places.

Transverse facial fractures, with a downward sagging of the maxillae, are best treated by supporting the facial bones by pressure exerted upward on the upper teeth or alveolar processes. It is often not practical to do this by bandaging the lower jaw against the upper, because the support is inadequate, and because in such cases the nasal fossae are almost invariably obstructed by swelling and the patient must breathe through the mouth. (See emergency treatment of fractures.) We believe the most practical and efficient method of supporting the maxillary and facial bones under these circumstances is to use a Kingsley splint reversed, after the method suggested by Dr. John S. Marshall. It consists in applying a Kingsley splint to the upper jaw and supporting it from above with a head bandage, or preferably a celluloid cap or a cap made of padded metal bands. Impressions are first taken of the upper and lower teeth in modeling compound, casts made and arranged with

the upper and lower teeth in correct occlusion. A cast or swaged metal splint is made over the teeth of the upper jaw, and to the buccal surface of the splint covering the molar teeth on each side

Fig. 28.—Showing a method of supporting one maxilla, after fracture through the body, by wiring the lower to the upper jaw on the sound side.

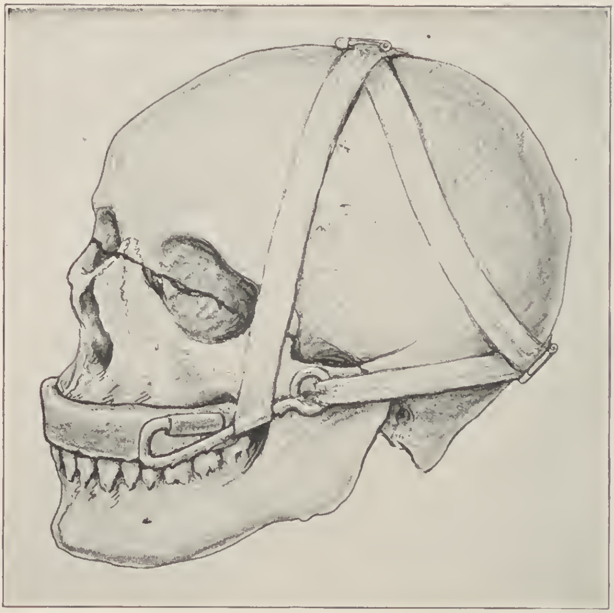


Fig. 29.—Marshall's method of supporting the maxillæ, in transverse fracture of the face, with a Kingsley splint. The arms of the splint, which are detachable, protrude from the mouth at each corner and lie close to the side of each cheek.

are soldered heavy wires, which are curved to extend out of the corners of the mouth and project backward over the cheeks. The splint may be cemented to the upper teeth and holds the fractured

bone firmly against the base of the skull by means of straps attached to the wire on each side and passing over the vertex of the skull (Fig. 29). A very useful head gear for this purpose has been devised by Aiguier.

This splint is to be retained until the bones have attained sufficient anchorage to hold them in position. If there is much loss of bone on either side of the nose in front, the lower part of the maxillae may have only a fibrous attachment or may be drawn upward.

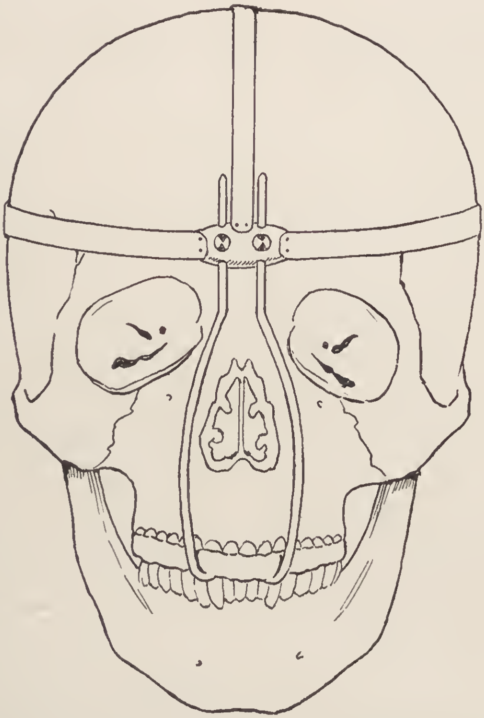


Fig. 30.—Swaged metal splint with rigid bars attached to head cap, for comminuted fracture of the upper jaw.—After Ombrédanne.

In the mechanical treatment of a case with much loss or comminution of bone between the palate and the base of the skull then the Marshall modification of the Kingsley splint is not applicable, for the upward pull of the bands will tend to displace the palate and alveolar parts upward. In such cases the upper alveolar arch is either to be fixed to the lower by intermaxillary wiring of the teeth (Fig. 28) or a swaged metal splint is cemented to the upper teeth and attached to a fixed head cap by metal rods that will hold the

dental arch in its proper relation to the lower and maintain its proper distance from the base of the skull. Later, if necessary, a bone graft bridge may be implanted to give stability to the maxillary arch. Various external pressure pads may be fixed by rods to the jaw splint (Fig 30).

## FRACTURES OF THE LOWER JAW

Owing to its position, the lower jaw acts somewhat as a guard to the rest of the face. It is more exposed to violence and is more often fractured than any other of the face bones. Owing to its loose connection with the skull, fractures of the lower jaw are much less likely to be complicated by skull or brain injury than a fracture of the upper jaw. It is a fracture that frequently occurs in fist fights, and naturally alcoholism is often a predisposing factor. It is much more frequent in men than in women. In war surgery it is comparatively common and is a frequent complication of more extensive injuries.

### Character of the Injury

The mandible may be broken by direct or indirect violence in any part. Because of the tooth sockets, and its more exposed position, fractures of the body are more common than those of the ramus and its processes, the latter constituting less than 5 per cent of the breaks. The former are more frequently caused by direct, the latter by indirect, violence. The bone is very hard and brittle, and splintering at the site of fractures is not uncommon, especially with gunshot injuries. Fractures of the body usually communicate with the mouth cavity and are therefore compound.

**Seat of Fracture.**—The most frequent single seat of fracture is the region of the mental foramen. The bone is weakened here by the mental foramen and by the peculiarly attenuated internal structure of the bone at this place, which is one of the fixed points from which growth extends. At this position also, is the middle of the curve in the body of the jaw, and finally the large socket of the canine tooth is situated in this region. Fracture may also occur in the region of the angle, between the angle and the mental foramen, and at the symphysis menti. Fractures of the ramus, the condyloid and coronoid processes are rare, owing to the protection afforded by overlying muscles. Fracture of the condyloid process is usually produced by a blow on the opposite side of the chin. When a fracture occurs in the region of the angle the direction of the break is usually

anterior from below upward, generally at an angle of about 60 degrees from the horizontal. It is our experience that the lower jaw is almost as frequently broken in more than one place as in one place only, the fractures usually occurring on opposite sides. The fractures may occur at corresponding places on the two sides, or at different places, according to the direction of the breaking force. It frequently happens in these cases that the point of impact of the breaking force will be situated midway between the two points of fracture. Thus, an individual will frequently be found to have received a blow in the region of the right canine tooth, with no fracture at this point, but with resulting fractures through the angle on the right side and the mental foramen on the left side (Fig. 44).

**Displacement.**—While the displacement of the fragments of the fractured lower jaw may have been primarily produced by violence, it is always maintained or modified by the action of the muscles to which the jaw gives attachment. In treating fractures of this bone, it is not of so much importance to be acquainted with the large assortment of the various forms of apparatus that have been devised for this purpose, as to understand the muscular actions that caused displacements. With this knowledge, a relatively simple armamentarium will be sufficient to obtain nice results in nearly all cases.

The lower jaw is a bar of bone, bent at the chin and at the angles, and somewhat loosely attached to the base of the skull at the condyles. The axis of motion in the simple action of opening and closing the mouth is not at the condyles, but near the upper openings of the inferior dental canals, which are situated in the middle of the ramus at the level of the occlusal plane of the molars. On the intact jaw, the actions of its various muscles are nicely balanced; but when a fracture occurs, the action of certain groups is no longer opposed, and displacement is produced and maintained.

In the diagrammatic schemes here illustrated, no attempt is made to include the finer actions of the muscles, but only those which are responsible for the gross displacements that ordinarily occur. The displacement will depend upon the direction and position of the fractures or fracture; the amount of displacement in any one place will depend upon the amount of laceration of soft tissues covering the bone, and the direction of the fracture. It will simplify the presentation of the subject to consider the displacement that may occur in the horizontal and in the vertical planes separately, and leave the reader to draw conclusions as to what will be the actual displacement in any particular instance.

The mylohyoid muscle, which forms the floor of the mouth, extends from the concavity of the body of the mandible to the body of the hyoid bone, and the direction of its pull is represented by the finer arrows in Fig. 31. The geniohyoglossi, digastric, and geniohyoid muscles together make a strong muscular mass that extends from the back of the symphysis to the body of the hyoid, and their combined pull is represented by the two heavy arrows in Fig. 31. In a

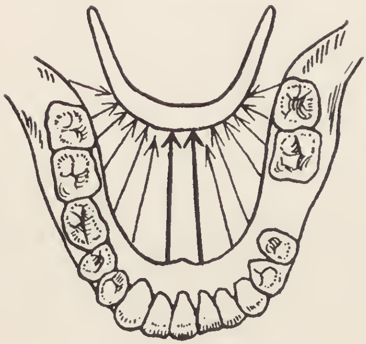


Fig. 31.

Fig. 32.

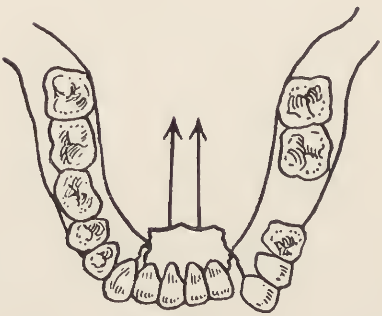


Fig. 33.

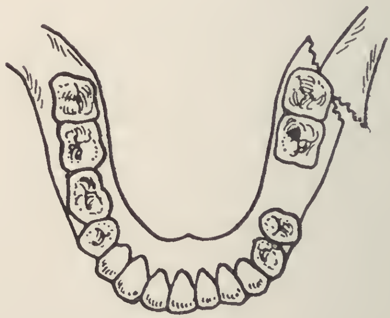


Fig. 34.

Fig. 31.—The arrows show the direction of horizontal traction of the mylohyoid, geniohyoid, geniohyoglossi, and digastric muscles on the jaw. The light arrows represent the fibers of the mylohyoid muscles, and the two heavy arrows represent the geniohyoid, geniohyoglossi, and digastric muscles.

Fig. 32.—Diagram showing possible horizontal displacement in a fracture in the bicuspid or molar regions.

Fig. 33.—Diagram showing possible horizontal displacement in a double fracture in the mental portion of the body.

Fig. 34.—Diagram showing possible horizontal displacement in a fracture of the body near the angle.

vertical fracture at the symphysis, the muscular balance will not be disturbed, and there will be no horizontal displacement. In a fracture or fractures of the body at any place between the symphysis and angle, granting that the mucoperiosteum is torn, and unless pre-

vented by the direction of the lines of the fracture, the displacement will be as shown in Fig. 32. The portion of the mylohyoid attached to the smaller fragment will draw the latter toward the median line. The whole of the mylohyoid of the opposite side together with the muscles attached to the symphysis will draw the mental portion of the larger fragment backward and to the side of the fracture. If there is a fracture on both sides, then the mental fragment might

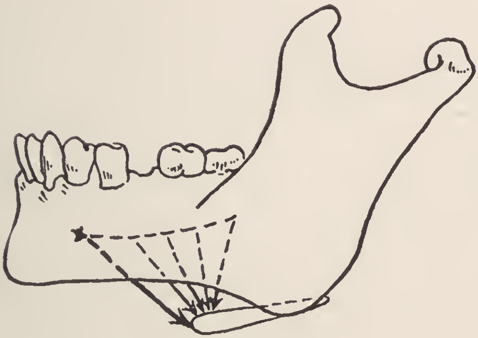


Fig. 35.

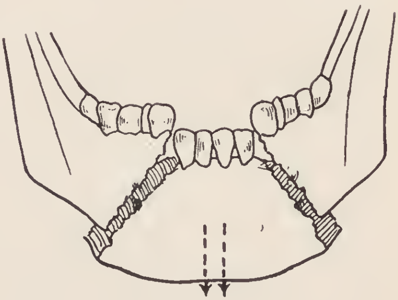


Fig. 37.

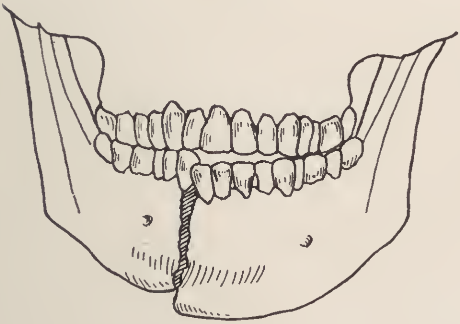


Fig. 36.

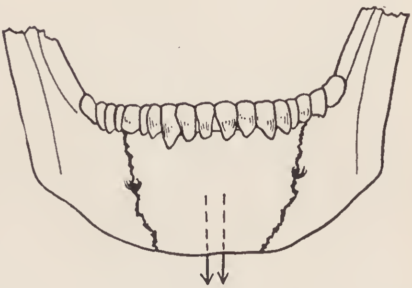


Fig. 38.

Fig. 35.—Showing the direction of traction of the geniohyoid, geniohyoglossi, digastric and mylohyoid muscles.

Fig. 36.—Diagram of a fracture in front of the cuspid showing characteristic displacement.

Fig. 37.—Diagram showing possible vertical displacement in a double fracture of the mental portion of the body.

Fig. 38.—Diagram showing an instance in which, owing to the directions of the planes of fracture, there could be no vertical displacement.

be pulled backward (Fig. 33), but as can be readily understood, the direction of the line of fracture may be such as to prevent this displacement. In fractures near the angle, the body may be drawn backward on the fractured side (Fig. 34).

The hyoid bone is situated on a lower plane than the attachment of the muscles to the inner surface of the body of the mandible, and

therefore they all draw the bone downward as well as backward, most of the force being expended on the mental portion (Fig. 35). As long as the body of the bone is intact, until the temporals, masseters, and internal pterygoids voluntarily relax, these more powerful muscles neutralize the downward pull of the muscles attached to the hyoid bone. If, however, a break occurs at any place between the angle and the symphysis, unless prevented by the direction of the line of fracture, the mental fragment will be pulled downward as well as backward. If the fracture is single, there will be but a downward tilting of the mental fragment, greatest at the site of fracture (Fig. 36). If there is a fracture on each side of the symphysis, the mental fragment may be pulled bodily downward as well as backward (Fig. 37), but in the case of either the single or double fracture, the line of fracture may be such as to preclude displacement (Fig. 38).

In any fracture of the body, whether single or multiple, there is apt to be a combined vertical and horizontal displacement, but its occurrence will be governed by the principles just illustrated. In a double fracture of the anterior part of the body, the backward dislocation of the mental fragment might allow the tongue to fall back on the glottis and cause dyspnea.

The muscles of mastication are attached to the ramus of the jaw and its processes. Of these, the masseter, the temporal, and the internal pterygoid are concerned in closing the mouth, while the external pterygoid assists the mandibulohyoid muscles in opening the mouth. The direction of the pull of these various muscles is illustrated in Fig. 39. The internal pterygoid muscle passes downward, backward, and outward to the inner surface of the ramus, while the masseter passes downward, backward, and relatively inward to its outer surface. The masseter being the most powerful may, in fractures in front of the angle, cause an outward tilting of the lower end of the ramus. In a fracture at the angle the pull of the mandibulohyoid muscles will tend to draw the body backward. If a considerable part of the masseter and internal pterygoid muscles remains attached to the posterior end of the body fragment, this may be drawn upward, so that the lower posterior molar tooth is locked behind the corresponding upper, the chin is depressed, and the lower incisors do not come up to occlusion. In a fracture of the posterior part of the body, unless prevented by the direction of the break or the presence of one or more occluding teeth in the posterior fragment, the lower end of the ramus may be tilted forward and pos-

sibly laterally. The direction of the lateral displacement will depend upon the direction of the break (Figs. 34 to 40).

In fractures of the ramus itself, there is, as a rule, little or no displacement, but a fractured coronoid process may be drawn upward and backward by the temporal muscle. In a fracture of the neck between the ramus and the attachment of the external pterygoid, the condyle may be drawn forward by the latter muscle (Fig. 41).

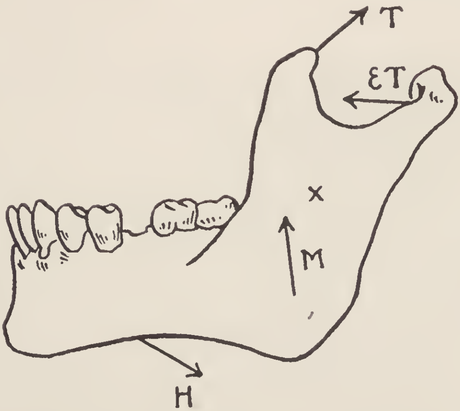



Fig. 39.—Diagram indicating by arrows the direction of traction on the jaw of the various groups of attached muscles. T, temporal muscle; M, masseter and internal pterygoid muscles; ET, external pterygoid muscle; H, muscles attached to the hyoid bone; X, axis of motion in opening the mouth.

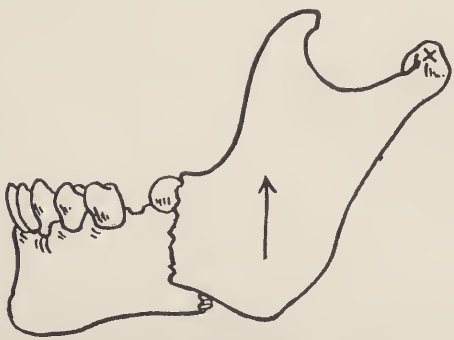



Fig. 40.—Diagram showing possible forward displacement of the ramus in fracture of the body at the angle.

The hyoid bone is not fixed, but its position depends upon the tone of the various muscles to which it furnishes attachment; therefore the act of swallowing, talking, or even moving the head will often influence both the pain and the displacement of a fracture in the body of the lower jaw. In fractures with loss of substance this is always magnified.

**Symptoms and Diagnosis.**—Fractures of the mandible have the symptoms common to other bones, viz., sharp pain, disability, swelling, deformity, abnormal mobility, and crepitus. Usually a fracture may be recognized or excluded by seeking for localized points of greatest tenderness. If a point along the jaw-bone is found to be tender to finger pressure, it may mean that there is a fracture at this site, or simply that there is a localized bruise. If, however, pressure upon the jaw-bone at several different points causes distant pain at

Fig. 41.—Fracture of neck of condyle, showing latter drawn forward by external pterygoid muscle.

one certain point, that is also sensitive to local pressure, then this may be taken as strong evidence of a fracture at this site. For instance, in a fracture at the symphysis, there may be absolutely no displacement, but the chin will be found tender to pressure; and pressure on the jaws at the angles will cause discomfort at the chin, owing to the force being transmitted through bone to the site of fracture. If the site of suspected fracture is near or above the angle, the test is made by pushing the chin backward and drawing it from side to side.

Crepitus is rarely a factor in making the diagnosis. If true bony

crepitus is detected, it is to be taken as certain evidence of a fracture, but crepitus is to be sought only by the gentlest of manipulations. By grasping one of the fragments in each hand, they can be made gently to move up and down one upon the other, which is indicated by the adjacent teeth interchanging levels.

Where any considerable number of opposing teeth are present, the diagnosis of a *fracture of the body* is usually self-evident, even though the displacement be slight. In fractures behind the angle and in fractures of the body with no displacement, diagnosis is usually best made by the use of the x-ray and the noting of points of greatest tenderness.

Fig. 42.—Fracture high up in the ramus.

In *fracture of the ramus,* a valuable point in diagnosis is that when the mouth is open as far as possible, the occlusal surfaces of the upper and lower molar teeth on the affected side are closer together than those on the sound side, owing to the upward pull of the masseter and internal pterygoid muscles.

Fracture of the *condyloid process* may be diagnosed by history of a blow on the opposite side of the chin, swelling and pain in front of the ear, limitation of motion, and deviation of the chin toward the affected side when the mouth is opened. The median line of the lower teeth will be nearer the affected side as compared to that of the upper teeth. It is sometimes difficult to secure a good radiogram depicting this injury.

Fig. 43.—Horizontal film, showing fracture through symphysis.

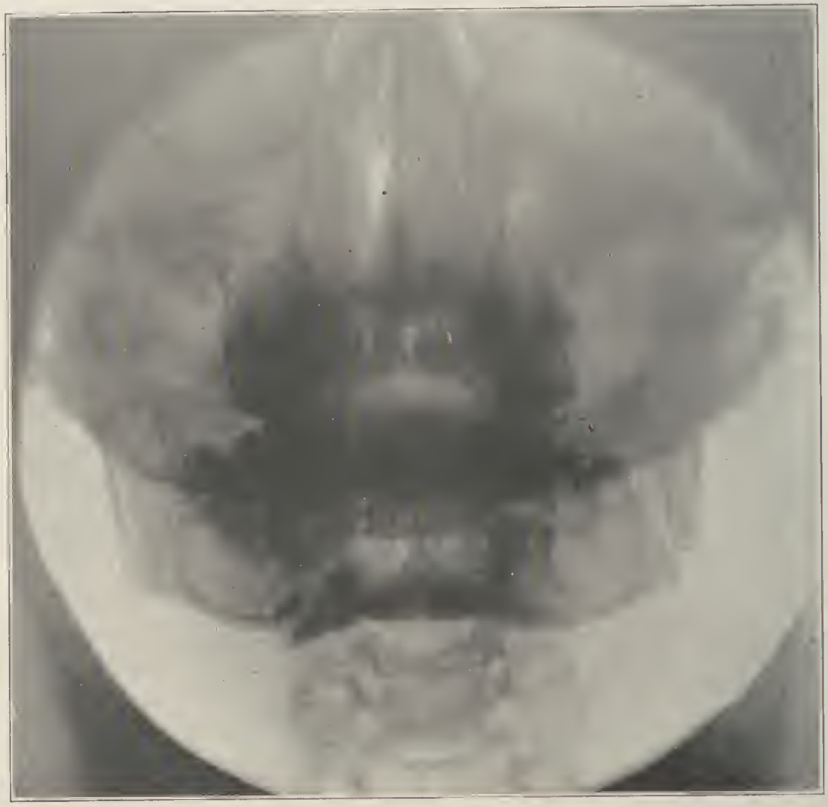


Fig. 44.—Antero-posterior view, showing fracture through right angle and left mental foramen.

Fig. 45.—Fracture at angle.

Fig. 46.—Fracture involving root of last molar.

**X-ray Examination.**—In all cases the x-ray is valuable in determining the direction of the fracture, injuries to roots of teeth, involvement of teeth in the fracture, and position of the fragments after reduction. Lateral x-ray plates with the head in the oblique position are generally the most serviceable in diagnosis of fracture of the body and ramus of the mandible. The two halves of the jaw should not overlap (Figs. 42, 45, 46). The region of the symphysis of the mandible is best studied radiographically by means of a 2¼ x 3 in. film inserted horizontally between the upper and lower teeth with its emulsion side down and the rays directed from beneath the chin (Fig. 43).

The seat of fracture or fractures having been determined, it is next important to examine the teeth in regard to their occlusion, general condition and suitability as points of fixation. The method of reduction and fixation to be employed will depend largely on these points.

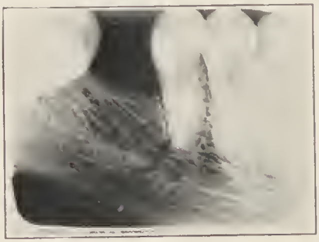


Fig. 47.—Greenstick fracture.

It should be ascertained which teeth, if any, encroach upon the line of fracture, because as a rule such teeth, if not removed, lead to infection, osteomyelitis, sequestrum formation, and delayed union. The removal of teeth in line of fracture may be delayed in exceptional circumstances where they may be useful in maintaining reduction.

## Treatment

Treatment of a fracture of the lower jaw includes two objects: the care of the tissues and of the patient, and the replacement and maintenance of the correct position of the fragments. Of these, the latter will be considered first. There are two ways of keeping the fragments in the correct position. One is to hold the broken fragments in their proper relation to the sound jaw and thus, indirectly, with each other; and the other is by means of dental splints, wires, or bone plates to directly fix the broken fragments to each other.

**Fixation by Bandage.**—It has long been recognized that where there is a full or nearly full quota of teeth the dental arch of the uninjured jaw should make an ideal splint for the fractured jaw, if adequate means could be contrived to hold the two arches in occlusion. The older and very commonly recommended method of applying a chin cup and bandaging the lower to the upper jaw with a Barton or a four-tailed bandage is seldom efficient where there is any displacement. Hippocrates recognized that this was not applicable to certain forms of fracture. Any bandage or apparatus that presses backward on the chin can tend only to produce displacement, and extensive observation has proved that about equally good or bad final results are obtained by no treatment as by this method. With any form of fixation, a bandage, for a few days, will give a sense of security that is grateful to the patient. In case of fracture, in which

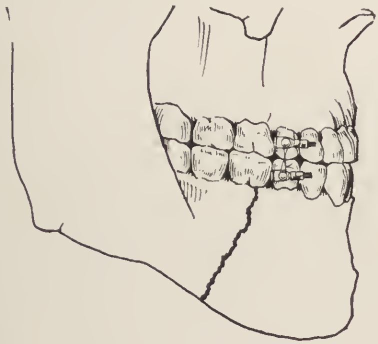


Fig. 48.

Fig. 49.

Fig. 48.—Diagram showing fracture treated by wiring the lower to the upper jaw by means of Angle fracture bands.

Fig. 49.—Gilmer's method of treating a fracture of the body by fastening the lower to the upper jaw by means of wires passed around the necks of the teeth. (From "Oral Surgery.")

there is no tendency to displacement, rest is all that is required, and this may be at least partially secured by a broad chin bandage.

**Fixation by wiring or plating the bone fragments** should never be attempted in recent fractures which communicate with the mouth. The fragments cannot be sufficiently immobilized by this method, and the wires or plates through mobility or infection nearly always work loose before union of the bone has taken place. In late cases of non-union, after the seat of fracture has ceased to communicate with the mouth cavity, and where the teeth are unavailable for fixation, external exposure and wiring or plating of the fragments may be justifiable.

In all cases, the principal object of treatment should be to restore the proper occlusal relationship of the lower with the upper teeth. Generally speaking, this can only be accomplished by utilizing the teeth for the attachment of fixation appliances, whether they be splints, bands or ligature wires. First of all, there will be described some of the commoner methods and splints employed at the present time, and then we will give in detail the method that has proved most satisfactory in our hands.

Fig. 50.—X-ray showing a silver wire passed around the mental portion of the body of the jaw and fastened to a wire on the cuspid above. This holds the bone up very satisfactorily. The dark spots in the orbit are shot received years before, and causing no symptoms.

**Dental Splints.**—Modern dental splints, as a rule, require the technical skill of the dentist for their construction and must be made for the individual case. There have been a number of adjustable stock splints, placed at the disposal of the medical profession, but these are not likely to be at hand when needed, and less likely to give really good service. The first requisite in the construction of a dental splint is an accurate reproduction of the dental arches and gums of both jaws. These are made from impressions taken in plaster of

Paris, modeling compound, or wax. From an accurately made negative impression, a dentist who has never seen the case could pour the positive casts, reconstruct the broken arch, and make a perfect fitting splint. All except those splints which are banded to the teeth can be applied by the surgeon. We could not better present this part of the subject than to quote Dr. Gilmer's description of his method of taking impressions and reconstructing the deformed arch:

"Preparatory to the formation of a splint, it is necessary to secure correct impressions of both upper and lower teeth and jaws. The upper may be taken in plaster alone, but the lower can be better and more accurately made by first taking it in modeling composition; from the inner surface of this, a small portion is cut away, plaster substituted in the place of the composition removed, and the whole is again placed over the teeth. An impression thus

Fig. 51.

Fig. 52.

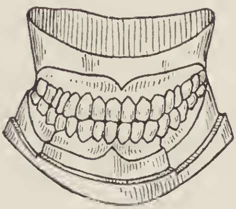


Fig. 53.

Fig. 51.—Showing plaster reproduction of dental arch and alveolar process in a fracture of lower jaw. Irregularities in alignment are shown at the sites of fracture behind the right second bicuspid and at the site of the left first bicuspid. (After Gilmer.)

Fig. 52.—Showing plaster reproduction of the dental arch and alveolar process of the lower jaw, sawed, ready for adjustment. (After Gilmer.)

Fig. 53.—Showing complete reproduction in plaster of Paris of both dental arches and alveolar processes. (After Gilmer.)

secured, if well done, will be correct and sharp. By this means an impression cup of modeling composition is produced, which fits the part, and very materially simplifies the operation. The sharper these impressions, the greater the certainty of a true occlusion after the union of the fragments. The lower impression may be made either in sections or entire, according to the case in hand; of the comparative expediency of these two methods the operator must judge for himself. If the displacement be so great as to render it improbable that a good impression may be secured in entirety, it is better to take it in sections. In taking the impression of the lower jaw it is useless to attempt to hold the parts in position, since the setting of the bone will be done after the appliance is made; therefore, all time given this effort will be lost, besides

in the majority of cases it is impossible to hold the parts in position while the impression is secured. From these impressions models are to be made (Fig. 51). If the impression has been secured in one piece, the cast from it is to be sawed in two on a line with the fracture (Fig. 52). The teeth of these two pieces are then carefully occluded with those of the upper model (Fig. 53).

"This is easily done, even though several teeth of each jaw are missing, as there is always an abraded surface of the teeth of one jaw which exactly corresponds with that of the other, but the greatest care must be exercised in

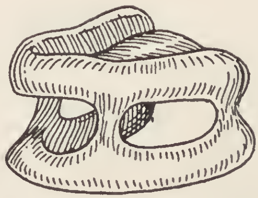


Fig. 54.—The Gunning splint. This is designed to treat a fracture with the jaws separated.

Fig. 55. Fig. 56.

Figs. 55 & 56.—Illustrations emphasizing the danger of dressing the mouth open (Gunning type splint) where the fracture is behind the last tooth. In these circumstances it is difficult to control the ramus and as a result the normal angle is liable to be distorted, leaving a permanent open-bite. This is frequently a difficult condition to correct.

fitting the parts together, as success depends upon the correctness of this part of the operation. If but the slightest difference is made in the occlusion, failure of perfect adaption is almost certain to ensue, as, the fragments not being held squarely together, an undue pressure will be brought to bear upon them at one point, while at another they will not touch; consequently, at that

point where there is too great pressure, inflammation will set in, and death of the bone will follow. Union may take place, but if it does, the occlusion will be faulty. When the occlusion of the teeth of the two pieces is made with the teeth of the upper cast, those representing the broken lower jaw are to be united by the addition of a little soft plaster. If the work has been done well, this reconstructed model represents the jaw as it was previous to the accident. The foregoing description of impressions and models holds good either in single, double or triple fractures, unless the impressions have been taken in sections, in which case there is no division of casts to be made.''

Dental splints are formed in various ways, according to the judgment of the operator and the case in hand. But those recommend themselves as preferable which are most simple of construction, and which take up least space in the mouth, having the requisite strength and other qualities which go toward making a splint serviceable.

The Gunning vulcanite dental splint (Fig. 54), formerly very extensively used, fixes the jaws with a space between the upper and lower teeth. This splint is particularly contraindicated in fracture posterior to the teeth, as the ''open-bite'' position produced by it does not maintain the fragments in correct relation, a V-shaped space being formed at the seat of fracture, which fills up by the process of repair, thus preventing the teeth from coming together after removal of the splint (Figs. 55 and 56). These vulcanite splints are also cumbersome and difficult to keep clean. They have been largely supplanted by improved appliances.

The Kingsley splint (Fracture of the Maxillæ, page 144, Fig. 29) is not ordinarily a very satisfactory splint for the lower jaw, on account of the difficulty of securing it in place; but the Kingsley and other splints of this class—namely, those that have a gutter corresponding to the alveolar arch and exert counterpressure from below the chin—all have the advantage that they can be used on an edentulous or nearly edentulous jaw. The arms on a Kingsley splint that protrude from the mouth may be attached to the plate of an artificial denture, which would convert the latter into a perfect fitting splint.

Dr. Hullihen, a dentist, of Wheeling, West Virginia, described a continuous dental splint which he had constructed for a case of resection of the alveolus, which has since often been used for the treatment of interdental fractures of the body (Fig. 57). It may be made of metal or vulcanite, celluloid or hard rubber, and is modeled over a plaster or metal reproduction of the dentures. The splint is supposed to fit accurately, and is cemented into place. Such a splint may include all of the teeth in the arch or an adequate number on each side of the fracture.

Splints of this type were formerly swaged over dies made from casts of the lower teeth, the metals used being usually gold or German

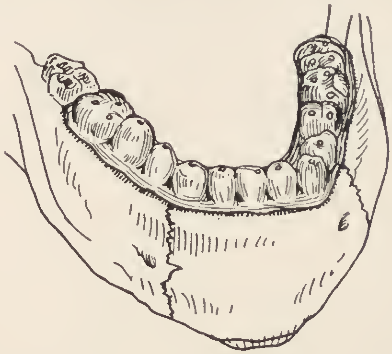


Fig. 57.—Hullihen continuous dental splint.—After Angle.

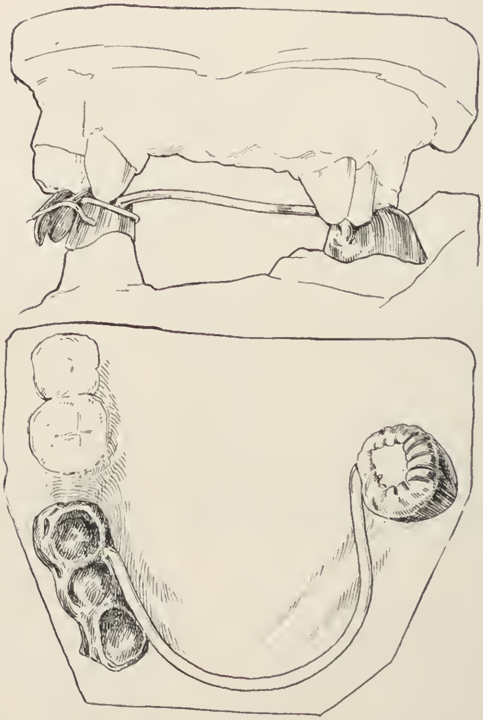


Fig. 58.—Band and wire splint. (After Hayes.)

silver. At the present time, they are generally cast in silver or aluminum, with a saving of time and greater accuracy in fit.

Effective splints of the Hullihen type have this advantage over wiring the jaws together—that they allow movement of the jaw almost throughout the treatment, thus permitting mastication of solid food, but they are only applicable in cases of interdental fracture, with firm teeth in each fragment. Even with sound teeth in each fragment, where there is much tendency to displacement and the fragments are not easily reduced and held reduced, fixation of the lower teeth to the upper is preferable.

In cases where there is loss of substance through the entire thickness of the mandible, or where there is a gap involving loss of several teeth, a modification of the Hullihen type of splint may be employed, consisting of swaged or cast caps covering the teeth of each fragment, the two sides being connected by a bridge or bar of metal crossing the gap (Fig. 58).

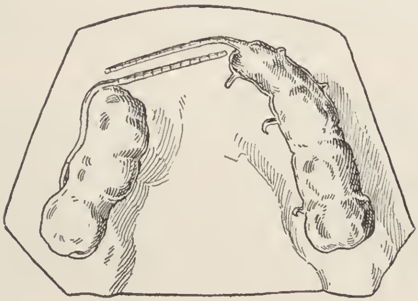


Fig. 59.—Sectional metal jacket and wire splint, showing the bridge made of two pieces of metal, the two halves to be put in separately and then the two pieces of the bridge bound together with fine wire. (After Hayes.)

The lower teeth may be attached to the upper by means of a swaged or cast metal splint made in two sections, one for the lower and one for the upper teeth, which when inserted fixes the upper and lower jaws together with the bite closed. Formerly, the upper and lower sections were soldered together in this position, which did not permit of getting the mouth open for examination, cleansing, exercise, etc. The more modern types have the two sections fastened together by means of ligature wire attached to hooks on the buccal and labial surfaces (Fig. 59), or by means of removable lock pins passing through tubes soldered on the buccal aspect of each section (Fig. 60). This form of splint may be used in cases of fracture where the teeth are few in number, where there is much displacement, and where the fracture is behind the line of teeth at the angle or in the ramus. In the latter it avoids the production of the V-shaped space

with malunion which is formed if the jaws are fixed with the bite open as when the Gunning splint is used. In these fractures at or behind the angle the essential point is to fix the main portion of the mandible in its proper relation with the upper jaw. The posterior fragment will usually take care of itself and come down into more or

Fig. 60.—Upper and lower cast metal splints with removable lock-pins to permit opening the mouth if desired.

Fig. 61.—Type of splint suitable for cases with sound teeth in each fragment. Band around molar tooth in posterior fragment, connected to segment of splint on anterior fragment of adjustable screw-bar.

less good position when the muscles relax. In any case, the important thing is restoration of the normal occlusion of the teeth.

In cases where there is a tendency to lateral displacement, lugs or inclined planes may be placed in splints in various places to engage

with the opposing jaw in such a way that, though normal movement of the mandible is not materially interfered with, still the fragments tending to lateral displacement are held in their proper position. (Figs. 61, 62, 63.)

Fig. 62.—Same splint unassembled, showing flange on side opposite to fracture to keep mandible from swinging over to affected side during mastication. Flange plays against upper molar teeth.

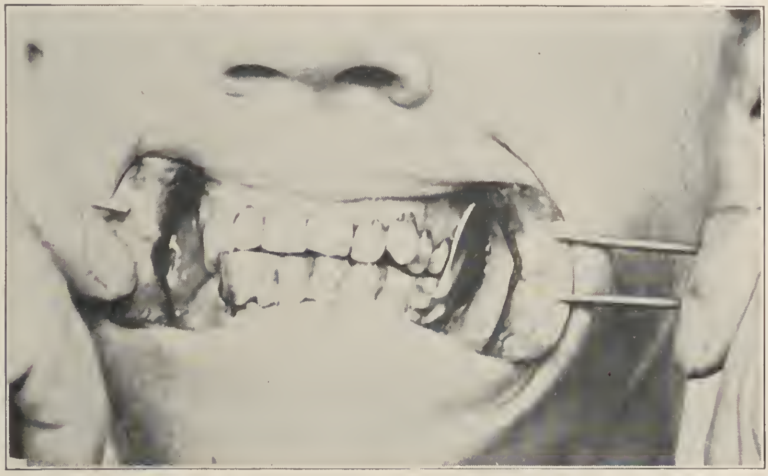


Fig. 63.—Same type of splint as shown in Fig. 62 in mouth.

**Fixation by Wiring the Teeth.**—While there is no question that an accurately made interdental splint fulfills the requirements of fixation once it is inserted, yet the making of a splint demands considerable experience, at least two days of time devoted to nothing else, and involves some expense. Most cases of fracture of the lower jaw

occur in persons in poor circumstancs who apply for treatment to free dispensaries or dental colleges, where students have to be depended upon for the making of splints. Busy dentists, even though experienced in this work, cannot give up everything and devote at least two days to the making of a splint. Dental students have other duties, such as operative work and lectures to interfere, and moreover are insufficiently experienced to produce accurate splints in the desired length of time. For these reasons, it has has been our experience that usually from two to three weeks elapse between the taking of the impressions and the insertion of the splint, which may not fit accurately even then. In the meantime, unless some other means of fixation has been used, the fracture may be in process of union in malposition. Therefore, for the fixation of the average case of fracture at the present time, we do not depend on splints, but employ immediate ligation of the lower to the upper teeth, thus reducing and fixing the fracture the first time the case is seen. This being accomplished, the case may be carried to completion by means of the wiring, or the wires may temporarily suffice until a splint can be made and inserted. The main object of employing any wiring method is avoidance of the difficulties and discomfort of impression taking and the delay in preparing interdental splints from these impressions. Other advantages of wiring are that there is no thickness of metal between the upper and lower teeth and the latter are not covered so that the state of the occlusion is under direct observation at all times; if, during the course of treatment it becomes necessary to remove a tooth, this can be done with less disturbance where the fracture is fixed with wiring than if a splint be cemented to the teeth.

**Methods of Wiring.**—Probably the earliest attempt at dental fixation of a fracture of the mandible was to fasten the teeth on both sides of the fracture to each other by means of a ligature crossing the site of fracture. Hippocrates recognized that to be efficient the ligature must be attached to teeth not immediately adjacent to the break. Wiring teeth of the same jaw together across the line of fracture is only efficient in a few cases where there is little or no tendency to displacement.

So far as we know, Dr. Thomas L. Gilmer, of Chicago, first advocated the direct fixation of the lower to the upper jaw by means of the teeth, as a treatment of fracture of the mandible.[1] The fixation may be done by dental bands (Fig. 48), or by wires fastened directly to the necks of the teeth (Fig. 49). If bands are used, the jaws are

[1]Thomas L. Gilmer: Archives of Dentistry, September, 1887.

fixed by silk or fine wire ligatures that extend between the bands, each having a lug or button on its outer surface for this purpose. The use of bands has certain points in its favor over the direct wiring of the teeth, but the latter is the more practical method; the materials required are nearly always at hand, and can be applied by any surgeon with a pair of artery forceps and a pair of scissors. The wire usually employed is Angle's brass ligature wire, No. 24 gauge, but in an emergency No. 24 or 26 soft iron wire that can be obtained in spools from the hardware shop or the florists, can be used. In Gilmer's original method (Fig. 49) it is seen that wires are twisted around the necks of two adjoining teeth in the upper and lower jaws, the upper and lower wires being then twisted together. While the upper wires are being twisted with the lower, the teeth should be held in occlusion by pressure from below the chin. There is this disadvantage in the method, in order to open the mouth the wires have to be cut, and if one wire breaks, it is necessary to remove all and repeat the entire procedure to replace one wire. We now employ a modification of Dr. Gilmer's valuable principle which permits during the course of treatment a ready opening of the mouth for replacement of a broken wire or other reason without disturbing the main attaching wires.[2] This method is described below.

When possible, it is preferable to have the teeth cleansed of all tartar before applying bands or ligatures. The wires are liable to set up a simple gingivitis, but this usually at once subsides on their removal. The teeth upon which traction has been made may become slightly loose in their sockets, but tighten up within a few days after the traction is released. The sharp ends of the wires are irritating to the inner surface of the cheeks and lips. A very efficient and easily obtainable protective is a gum formed by heating gutta percha tissue over a flame until it melts into a soft mass, and then with wet fingers moulding it over the projecting wires. Dental impression compound may also be used to cover the sharp ends of the wires.

If the teeth are wired while the patient is under a general anesthetic, and strangulation is feared from vomiting food or blood during recovery from the anesthetic, the stomach should be emptied by means of a tube before the jaws are fixed together; or, the wires can be attached to the teeth, and the fixation of the upper and lower together deferred until the patient regains consciousness. If the patient has been previously prepared for the anesthetic, there will usually be

[2]Ivy: Surgery Gynecology and Obstetrics, May, 1922, p. 670.
Eby, J. D.: Jour. Nat. Dent. Assn., 1920, p. 771.

nothing in the vomitus that will not pass out even though the teeth are fastened together.

**Description of Method.**—The wire employed is No. 24 gauge Angle's brass ligature wire. The instruments needed are a pair of hemostatic forceps, a pair of short-nosed scissors, and a tenaculum or a Backhaus' towel clamp (Fig. 64).

In preparation of the wire, a six inch length is folded around the

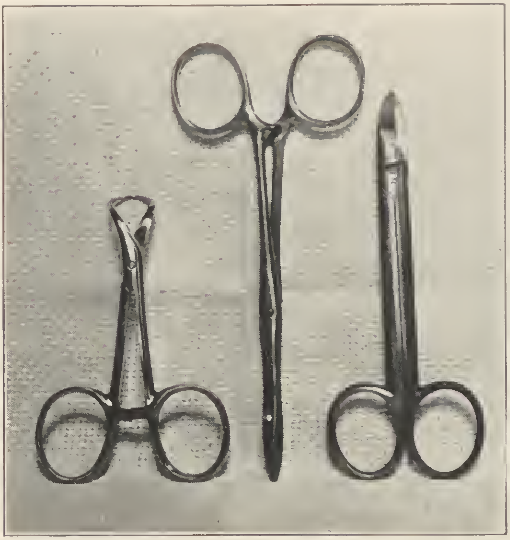


Fig. 64.—Instruments required in wiring teeth.

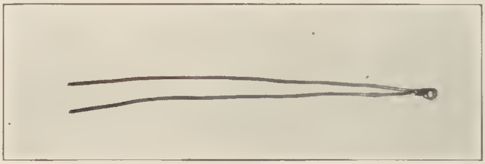


Fig. 65.—Eyelet twisted in strand of wire.

tenaculum, and a loop is twisted into the form of an eyelet as shown in Fig. 65. After selecting the teeth to be wired in pairs the ends of the eyelet wire are inserted from the buccal surface beneath the interproximal contact of for example the two premolars, as shown in Fig. 66. One end is drawn through around the anterior tooth and the other end around the posterior tooth, on to the buccal aspect, as shown in Fig. 67. This process is repeated on corresponding upper teeth. Then the ends of the wire in the case of the lower teeth are

twisted together with the eyelet projecting below the horizontal strand as shown in Fig. 68. In the case of the upper teeth the eyelet projects above the horizontal strand. In this way the upper and lower eyelets are prevented by the horizontal wires from coming too close to each other when subjected to the strain of the connecting wire. It is important that the eyelets do not project from the interproximal space any further than necessary to permit the passage of the connecting

Fig. 66.—Ends of eyelet wire inserted between premolars.

Fig. 67.—Ends of eyelet wire passed around premolar teeth.

wire. In twisting the ends of the wire, the first turn should be made as tight as possible by grasping the ends with the hands. This distributes the strain thus avoiding breakage. If further tightening is necessary, it may be done by grasping the ends of the wire with the hemostatic forceps, drawing the wire away from the teeth and twisting carefully at the same time. The eyelet may be prevented from disappearing in the interproximal space by engaging it with the tenaculum or towel clamp. The ends are then cut off short and bent

in so as not to irritate the lips. The selected teeth on the opposite side of the mouth are then treated in the same manner, and if desirable a third set of teeth is similarly wired. The upper and lower eyelets are now connected by passage through them of a third, connecting or tie wire (Fig. 68), the teeth brought into occlusion, and the ends of each connecting or tie wire twisted together (Fig. 69). In some cases of displacement the desired movement of a fragment

Fig. 68.—Ends of upper and lower eyelet wires twisted, and tie-wire passed through eyelets.

Fig. 69.—Upper and lower teeth drawn into occlusion, ends of tie-wire twisted and cut off short.

to restore proper occlusion can be produced by placing the upper eyelet in a position anterior or posterior to that of the lower eyelet, as the case may be. Complete reduction may not be brought about immediately on placing the wires, but will generally occur on taking up the slack of the connecting wires after twenty-four hours. A great advantage of this method is that if one wire breaks, it can be replaced without disturbing the other eyelet wires. If a patient is to receive

an anesthetic the eyelet wires may be placed before or during the operation and the jaws fixed with the tie wires after the danger of nausea is past. The tie wires may be cut at any time in order to test the fracture and if it be found that consolidation is not complete they may be immediately replaced without all the necessary work of starting from the beginning. The wires tend to loosen every few days, but can be easily tightened. The slight motion of the jaws due to loosening of the wires, as compared to the absolute rigidity of splints, is an advantage in the later stages of treatment, as it tends to stimulate bone regeneration. In a series of twenty-five consecutive cases

Fig. 70.—Radiogram showing upward tilting of long edentulous posterior fragment.

of fracture of the mandible treated recently, this method proved efficient in every case, and in none was it necessary to resort to splints.

Where a tooth necessary as a point of fixation in one jaw stands alone, the attachment of the eyelet wire may be modified by twisting it around the neck of the tooth with the eyelet on the labial or buccal surface.

This method of necessity entails the locking of the upper and lower teeth together, no matter where the fracture is situated. But the disadvantages of this are not so important as the delay usually encountered in having a splint made, particularly if the splint does not fit properly when made.

Occasionally a fracture of the body of the bone will be encountered in which molar teeth have been lost, leaving a long posterior fragment without teeth. In a case of this kind there is generally a tendency

71 72 73

Fig. 71.—Diagram illustrating upward tilting of long edentulous posterior fragment.
Fig. 72.—Diagram showing insertion of modeling composition to keep downlong posterior fragment.
Fig. 73.—Diagram showing teeth wired, and long posterior fragment reduced by modeling composition.

for the anterior end of the posterior fragment to be tilted upward by the temporal, masseter and internal pterygoid muscles, until the soft tissues meet the occlusal surfaces of the upper molar teeth (Figs. 70

and 71). To bring about reduction here, a piece of soft modelling composition may be inserted to cover the gum over the posterior fragment, filling in the space between it and the upper molars, and allowed to harden while the mouth is open. The modelling composition is then removed from the mouth, trimmed to as small proportions as possible, and reinserted (Fig. 72). The teeth on the large mandibular fragment are then wired up in occlusion with the upper teeth, the modelling composition at the same time keeping the posterior

Fig. 74.—Fracture at angle with third molar in line of fracture.

fragment down in place (Fig. 73). Ulceration of the gum overlying the posterior fragment sometimes is seen from pressure of the last upper molar. In this case it may become necessary to extract this tooth.

Roots of teeth encroaching on the line of fracture frequently give rise to infection sooner or later, and as a general rule the wisest plan is to remove them early, provided this can be done without too much traumatism to the fracture. However, in certain cases it may

be advisable to retain such a tooth even at the risk of infection. This applies to a fracture just in front of the last molar tooth, where loss of the tooth would mean upward displacement of the posterior frag-

Fig. 76.

Fig. 75.

Fig. 75.—Diagram illustrating third molar in line of fracture at angle.
Fig. 76.—Diagram showing value of retention of last molar for reduction of posterior fragment.

ment owing to lack of opposition from the upper molars (Figs. 74, 75, and 76). After a week or ten days of reduction, the posterior fragment will usually remain down in position without help from the

tooth in the line of fracture, and this can then be removed (Fig. 77).

In fractures of the ramus situated within the attachment of the masseter and internal pterygoid muscles, there is rarely a lateral displacement. All that is needed is to give rest by fixing the lower to the upper jaw.

Fractures of the coronoid process are the rarest of all and are usually associated with a fracture of the neck of the condyle. Such a fracture of itself would require but little treatment except fixation of the lower jaw for the control of the pain. If such a fragment were

Fig. 77.—Radiogram showing reduction of posterior fragment maintained after late extraction of third molar.

to later interfere with proper movement of the jaw by becoming attached to a fractured condyle, the coronoid could be removed.

When symptoms are present, a fracture of the neck of the condyle should be treated by fixing the lower to the upper jaw. If the condyle is drawn forward by the pull of the external pterygoid muscle, the displacement cannot be corrected, but the larger controllable fragment, the whole of the remaining part of the jaw, can be brought forward to a corresponding position. This is done by fastening an inferior molar to a tooth above and in front of it—as the first lower molar to the first upper premolar. The correct position could be

determined by an x-ray examination. The condyle may have to be removed. (See Ivy, Trans. Philadelphia Academy of Surgery, Annals of Surgery, 1915, lxi, 502-506.)

The method of wiring the upper and lower teeth, as given above, proves efficient for the reduction and retention of 90 per cent of fractures of the mandible met with in civil practice, no matter where situated. For the occasional case, complicated by marked comminution or loss of bone substance, with destruction of teeth, in which fixation for several months may be required, the cast metal upper and lower splints, connected by lock-pins, are recommended.

**Treatment of edentulous cases or those in which an insufficient number of teeth are present for wiring, or splinting.** It is usually recommended that for edentulous cases full upper and lower vulcanite dentures can be inserted, fastened together, and held in place with a bandage. In our experience it is impossible to provide sufficient fixation of the fragments in this way.

Another method can be tried that has already been referred to, viz.: in edentulous cases where there is no break in the mucous membrane, fixation can sometimes be accomplished by wiring or plating the fragments, the site of fracture being exposed under aseptic precautions through a skin incision. In as small a bone as the mandible, especially in an edentulous person where much absorption has taken place, these metal plates are difficult to apply firmly.

A much better plan for edentulous cases is circumferential wiring of the bone, first employed by G. V. Black (Gilmer, Lectures on Oral Surgery, Chicago, 1901). A vulcanite splint is first made like a saddle, to cover the lower ridge on each side of the fracture. Or, if the patient has a full lower vulcanite denture, this may serve the purpose of a splint. Under local anesthesia, a small incision is made through the skin at the lower border of one of the fragments, and a small curved trocar and cannula are passed through this incision close to the bone on the lingual side, until the mucous membrane of the mouth is pierced. The trocar is then removed and one end of a 16 or 18 gauge silver wire is threaded through the cannula from below. The cannula is withdrawn and by means of the trocar is passed downward from the mouth close to the bone, this time on the labial side, to emerge at the original skin opening. The other end of the wire is then passed up through the cannula, and the cannula withdrawn. It is thus seen that the wire passes around the bone. The ends of the wire are now twisted over the vulcanite splint or denture so that the bone fragment is drawn up snugly in contact with the splint. An-

other wire is similarly passed around the other fragment and twisted over the splint. The circumferential wire is well tolerated and may be retained for several weeks, the skin incision frequently closing without suppuration. This method is particularly useful in drawing up and maintaining a central edentulous fragment in a case of double fracture (Figs. 79, 80 and 81). Even when teeth are present in a fracture through or just in front of the canine socket, it often happens that a good purchase cannot be had on the teeth of the anterior

Fig. 78.—Radiogram showing fixation of edentulous case by circumferential wiring.

fragment. Under these circumstances circumferential wiring may be found useful, the ends of the wire in this case being fastened to an upper canine (Fig. 50).

**Care of the Tissues.**—Fractures of the body are nearly always compound, the possible exceptions being fractures in jaws that are without teeth at the site of fracture. Whether or not an open fracture of the body will become infected depends largely upon the amount of injury to the coverings of the bone and the amount of separation.

Fractures of the ramus or its processes are usually not open frac-

tures. In every fracture of the body where there has been a distinct separating or splintering of the fragments, it is a safe procedure to drain externally by inserting a small drain through a stab wound, that will communicate with the break, made under the jaw or chin.

Fig. 79.—Diagram of double fracture in edentulous jaw.

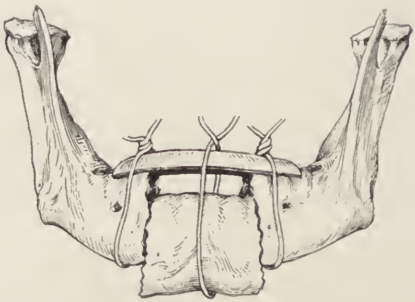


Fig. 80.—Same as Fig. 79 after application of splint and circumferential wires.

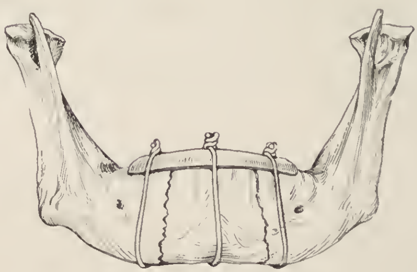


Fig. 81.—Same as Figs. 79 and 80 after complete reduction.

If suppuration does not supervene, the drainage wound will close without leaving a noticeable scar. If suppuration occurs, the bone and the soft tissues will both be conserved by this puncture. This can be done with a local anesthetic (Fig. 82).

In simple fractures the inferior dental artery may be torn across, but the bleeding will cease on adjusting the fragments. No attention is to be paid to an injury of the inferior dental nerve. If neuralgia should follow, it should be treated as outlined in Chap. XXVIII.

An ice bag applied for a few days over the site of fracture so as to keep the skin cool, not cold, will limit the inflammation and usually relieve pain. (For the care of accompanying injuries of the soft parts, see Chap. VII.) Except for some special reason, no piece of

Figs. 82.—Showing characteristic swelling that frequently occurs and often persists for months after an infected fracture. This may take place without any evident suppuration at the site of fracture. It is prevented by immediate drainage of the fracture as described on page 178.

bone that is still attached to the soft tissues should be removed. The establishment of drainage from below will give an attached fragment a fair chance to live and unite.

Reports from the war zone give many instances where a complete segment of the jaw bone had apparently been destroyed, yet with free drainage, care of the tissues, and maintenance of the gap by a bridge splint, regeneration of bone in the defect had taken place.

In open fractures that are seen, after suppuration has set in, free

external drainage should be made from below, but fragments of bone should not be removed until they have become completely detached. Unless they are very large, they will usually work their way out from above or below. (Fig. 83.)

**Care of the Mouth.**—While it is desirable to apply splints at the earliest possible moment, still the teeth should be first cleansed and if there are suppurating areas draining into the mouth these should be cared for either by the use of frequently changed gauze packs or by establishing inferior external drainage. The use of external drainage should be more freely employed than is commonly the practice.

The *intraoral treatment* consists of the following:

1. Tincture of iodine is applied every other day to the gums and teeth by means of small pledgets of cotton.

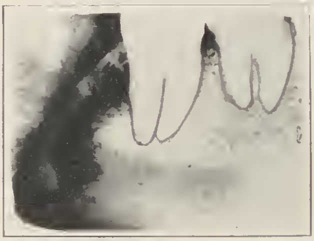


Fig. 83.—Sequestrum in line of fracture.

2. Pledgets of cotton saturated with hydrogen peroxide are rubbed over the teeth and all mucous surfaces twice daily.

3. The mouth is irrigated with an antiseptic fluid 3 or 4 times a day. This may consist of a saturated solution of boric acid, potassium permanganate, 1-3000, or sodium hypochlorite solution in the form of Dakin's fluid or chlorazene. A convenient method is to have a glass irrigating jar filled with the fluid suspended over the head of the patient, fitted with a rubber tube and glass cannula through which the mouth can be irrigated at frequent intervals.

4. Deposits of tartar are scaled from the teeth and the surfaces polished. The mouth is gradually cleared of broken roots and fragments. If able, the patient is allowed to clean his own teeth with a brush.

**Feeding During the Treatment of a Fracture of the Jaw.**—Food and fresh air are important factors in the treatment of any fracture. With a fracture of the jaw, especially if the jaws are wired together,

especial attention must be paid to the feeding. With an interdental splint, ordinary soft foods and chopped meat can be taken from the first. When the jaws are wired together, the diet must often be restricted entirely to fluids.

It is never necessary to extract teeth to provide space for the passage of food in patients wearing interdental splints or having the upper and lower teeth wired together. There is always sufficient room, either through places where teeth have been previously lost or behind the last molar teeth for liquid food to pass.

The liquid diet is usually administered through a tube. As much variety as possible is essential in order to provide sufficient nourishment. The patient on liquid diet loses weight at first, but after a time with proper selection and variation he begins to regain it. Not all patients thrive on a purely albuminous diet, and it is well to mix it with liquid potatoes, gruels and fruit juices. The basis for the dietary in the average patient for 24 hours should be approximately: Milk, 4 pints; eggs 4; soup, 2 pints.*

**Time Required for Union** depends upon the character of the fracture, the number of fractures, and the reparative effort of the individual. In single fractures, without suppuration and no appreciable loss of bone, fairly good union may occur in three weeks, although as a rule at least five weeks of fixation are required. In a series of 31 cases recently studied (Ivy, Journal A. M. A., July 29, 1922, p. 295), the average time required for firm union was 48 days, the longest being 109 days and the shortest 21 days. While a double fracture should unite as quickly as a single fracture, there is more tendency to displacement, and greater firmness is necessary before the splints can be dispensed with. Suppurating open fractures and fractures in which there is considerable loss of bone will require the longest period of fixation.

**Delayed Union.**—Union may be retarded by lack of approximation or by lack of fixation of the fragments, by the interposition of detached bone fragments, teeth, or a foreign body, by local infection, and by some fault in the vital reparative effort.

Syphilis, tuberculosis, pregnancy, or any general depression may be responsible for delayed union, but, at times, no cause can be found.

*Five hundred grams of perfectly fresh chopped lean beef with an equal quantity of water, soaked for six hours at an ice-cold temperature, will, when the fluid is pressed out, yield 500 cubic centimeters of rich beef juice which may be taken raw or put into soups. The juice expressed from boiled or baked meats is much more palatable, but not so economical. Of course, no dependence should be placed upon beef teas or clear soups.

Besides specific and tonic treatment, the administration of the extract of thyroid glands is supposed sometimes to influence union favorably. Besides general treatment, the alignment should be preserved by appropriate splints, and the ends of the bone may be irritated aseptically with a rough instrument, such as a coarse file, as suggested by Dr. Gilmer. As soon as a fibrous union that preserves the alignment is formed, splints or other fixation may be dispensed with, as some

Fig. 84.—Double fracture with firm union in malposition, showing deformity.

Fig. 85.—Same case as Fig. 84 after osteotomy through original fracture lines and fixation in correct position.

movement often stimulates union. Nonunion is rare in fractures of the mandible, unless complicated by large losses of substance, as seen in gunshot fractures. About 11 per cent of gunshot fractures result in nonunion. The proper treatment here is by bone grafting, either by a pedicled graft from the mandible itself, or by an osteo-periosteal graft from the tibia, or by a thick graft from the tibia, rib, or crest of the ilium.

**Malunion.**—When pronounced, malunion may require division of the bone through the original line of fracture, reduction of the fragments, and fixation by wiring of the teeth or interdental splints, with restoration of the proper occlusion of the teeth. The best method of dividing through the line of fracture is by a Gigli wire saw, introduced in the same manner as the circumferential wire described on page 176, with a trocar and cannula. This operation usually requires

Fig. 86.—Modified Barton bandage for fracture of mandible and supporting submaxillary dressings, which avoids backward pull on chin. Turns are as follows: Vertex to chin, *under* chin to occiput, to vertex, to chin, *under* chin, to occiput, to vertex, etc.

a general anesthetic. Where splints are required for fixation, they should be made in sections, cemented to the teeth prior to operation, and locked in position with lock pins after reduction. (Figs. 84 and 85.)

**Bandaging.**—Bandaging in connection with fractures is of importance. The most useful bandage is a modification of the Barton, which avoids the disadvantage of the latter in making backward pressure on the chin (Fig. 86).

## CHAPTER XI

## DISLOCATION OF THE LOWER JAW

The mandibular joint is made up of the condyle of the mandible below, the glenoid fossa, and the articular eminence on the under surface of the temporal bone above. Posteriorly, the glenoid fossa is bounded by the delicate tympanic plate, which separates it from the external auditory canal. The roof between the glenoid fossa and the middle cerebral fossa is very thin. Between the condyle and the temporal bone there is an interarticular fibrocartilage that divides the joint into two compartments. It is surrounded by a capsular ligament, while three other ligaments add to its strength, as follows: The stylomandibular, extending from the styloid process to the posterior border of the ramus; the external lateral, closely incorporated with the capsular ligament; and the internal lateral, which is attached above to the spine of the sphenoid and below to the spine or lingula of the mandible. (Figs. 87 and 88.)

By **dislocation or luxation** is meant an alteration in the relation of the bony surfaces composing a joint.

### KINDS OF DISLOCATION

There are four varities of dislocation of this joint that have been described: forward, which is the ordinary form, and usually uncomplicated by any fracture; and an upward, a backward and an outward dislocation. Instances of any of the latter three varieties are extremely rare, and each of them is, of necessity, accompanied by a fracture. For convenience, the latter three will be considered first.

**Upward Dislocation.**—A severe blow upward on the chin while the mouth is open, or an upward blow under the angle, if the upper or lower posterior teeth are missing, might drive one or both condyles through the roof of the glenoid fossa into the skull. In such an injury the movement of the jaw would be limited, and the ramus would be apparently shortened.

Treatment would consist in trephining above the glenoid fossa, extracting the condyle, and possibly draining the middle cerebral fossa. The mandible could be retained in position by appropriate dental fixation.

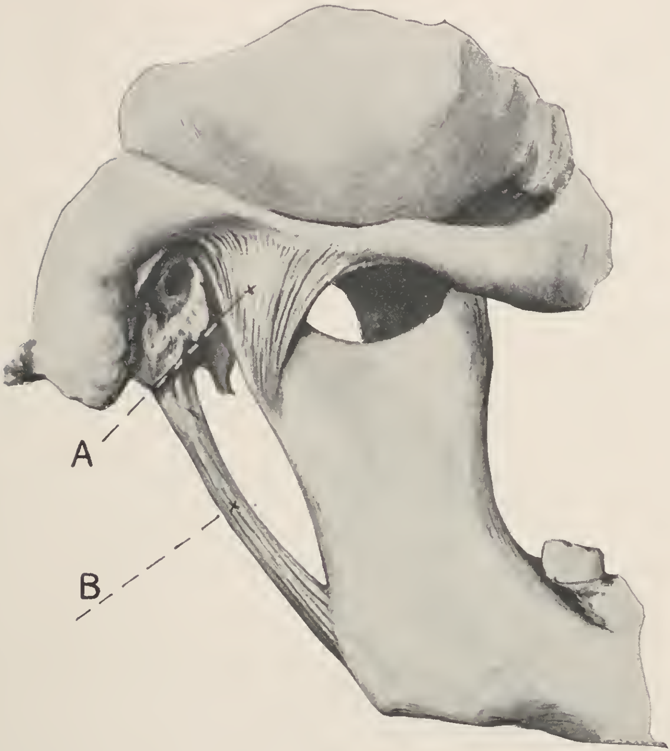



Fig. 87.—Ligaments of the temporomandibular joint viewed from the external surface. A, capsular ligament; B, stylomandibular ligament.


Fig. 88.—Temporomandibular joint. A, capsular ligament; B, external auditory canal; C, mastoid processes; D, upper joint compartment; E, intraarticular cartilage; F, articular eminence; G, zygoma; H, mandible.

**Backward Dislocation.**—A backward blow on the chin while the mouth is closed might drive the condyle against the tympanic plate with such force as to crush it into the external auditory canal. The chin would recede, and there would probably be bleeding from the canal; and an examination with an aural speculum would show obstruction of the canal. The condyle would be felt, or with an x-ray examination, would be seen to be in an abnormal position. If the backward dislocation is unilateral, the chin will deviate to that side.

Treatment will consist in drawing the jaw forward and retaining it by dental fixation. An attempt should be made to restore the auditory canal.

**Outward Dislocation.**—Robert has reported a case of outward dislocation. The body was fractured in front of the angle, and the condyle was to the outer side of and above the zygoma. To reduce the dislocation, the ramus was pushed outward until the condyle was freed from the zygoma, and the condyle was pushed down and into place. The jaw should then be treated as in a fracture in front of the angle.

**Forward Dislocation.**—Even this form of dislocation is comparatively rare, and is more frequent in females than in males. It has occurred as a result of drawing on the jaw in an attempt to deliver the head in difficult labor, but is much more rare in children and in elderly people than in the prime of life. When the jaws are closed, the condyle rests in the glenoid fossa; but as the mouth opens, the axis of motion being in the neighborhood of the inferior dental foramen, the condyle travels forward on the articular eminence. If from any cause the condyle is forced but a little past the crest of the eminence, usually without rupture of the capsular ligament, it may become locked in that position. This constitutes an anterior or the common dislocation of the jaw. The determining cause is usually an overactivity of the external pterygoid muscle, assisted possibly by the posterior fibers of the masseter, when the mouth is fully open. More rarely it is due to a backward blow on the chin when the mouth is open, which, by forcing the body and lower portion of the ramus backward, at the same time throws the condyle forward (Fig. 89). The jaw has been dislocated in the act of extracting a tooth, but in this case the dislocation is more probably due to muscular action, or from opening the mouth too widely, than the force used in the extraction. A unilateral dislocation has been produced by a blow on the posterior border of the ramus.

The amount of displacement varies greatly in different cases. In

a few the coronoid process has become engaged under the malar bone, and this has been regarded by some as the factor that prevents reduction in all instances, which is true probably in but a very small percentage of cases. The condition in most anterior dislocations of the jaw does not differ materially from that in a dislocation of the hip or shoulder. In each of these joints the head of the bone is held in a socket by the tension of the muscles and ligaments. If the head once crosses the raised border that surrounds the socket, the same muscular and ligamentous pull holds the head in its new position, and it is only by some manipulation that either relaxes or overcomes this muscular and ligamentous pull that the head can be returned to its socket. This view with reference to anterior dislocation of the jaw has been expounded at various times, but it is most

Fig. 89.—Position of condyle in forward dislocation.

clearly presented by Dr. Lewis A. Stimson in his classic chapter on dislocations of the jaw; and we are in such full agreement with the views which he holds that we cannot help following his text rather closely. The external lateral ligament is most closely concerned in maintaining the head of the condyle in its false position when it becomes dislocated anteriorly, the other ligaments contributing. When the condyle occupies the glenoid fossa, the direction of the external ligament is downward and backward. As the condyle travels forward, the point of attachment of the ligament on the neck of the condyle assumes a position directly inferior to its upper attachment. This would allow the ligament to become slack if the plane of the posterior surface of the eminence were not downward and forward. When the head reaches the crest of the eminence, the neck of the jaw and the ligament is in the same plane, and the latter is tense (Fig. 87). For the head to travel further forward without rupture

of the ligaments, the axis of motion must, for the moment, change from near the entrance of the dental canal to the point of insertion of the external lateral ligament. The head first tilts forward on this new axis, and then by the continuance of the force slides onward, carrying the inferior attachment of the ligament with it until the ligament is again taut. Where an anterior dislocation has occurred, the direction of the combined pull of the muscles of mastication is such as to hold the lower attachment of the ligament forward. The muscles of mastication can no longer tilt the head of the condyle backward, as they do under normal conditions, for now, with the ligament serving as a fulcrum, the posterior surface of the head is jammed against the eminence by the temporal, the internal pterygoid and the anterior part of the masseter, thus pulling forward and upward on the long end of the lever. It is probable that in most anterior dislocations the ligaments are not ruptured. There are, however, undoubted instances where the capsule has been torn, and it is likely that this occurs in all cases of primary dislocation where the head travels well forward of the eminence. In these instances the head is held in its new position by the muscles and the stylomandibular and internal ligaments. The position of the meniscus or interarticular cartilage in an anterior dislocation is a matter of some uncertainty. It is probable that it usually remains in place, the condyle slipping in front of it, but in some recorded instances this has not been the case.

**Symptoms of Anterior Dislocation.**—The mouth is at first held open and chewing is impossible. The chin is slightly forward, swallowing and talking are difficult, and the muscles are usually tense. Most important of all, the absolute sign, the condyle may be felt, or seen by means of the x-ray, to be in advance of its natural position. In a unilateral dislocation, the chin deviates to the opposite side, a point of differentiation from fracture of neck of the condyle, in which the chin deviates to the injured side.

**Treatment** consists in reducing the dislocation and holding the head in the socket until the stretched or torn ligaments have time to unite or recover their normal tone. Reduction may be difficult if attempted soon after the dislocation has occurred, owing to spasmodic contraction of the muscles. A general anesthetic may be necessary to overcome this muscular contraction. Later the muscles usually relax, permitting reduction without an anesthetic. Reduction may be accomplished in one of two ways: (1) By traction that forces the ligaments and muscles to yield sufficiently to allow the

head of the condyle to pass the obstruction and slip into the socket, or (2) by manipulations that bring the head, in reverse order, into the various positions which it assumed while leaving the fossa. The latter course is the preferable way, requiring less force and inflicting less pain; while the former, by stretching the lateral ligaments, might inflict more damage to the joint than was sustained at the original injury.

**Reduction by Traction.**—This is the widely adopted method. The body of the jaw is grasped on each side, with the fingers under the chin and the thumbs within the vestibule of the mouth to the outer side of the molars. While downward traction is made on the rami, an attempt is made at the same time to raise the chin and push the condyles backward into the sockets. The attempt may be made on one side at a time. The thumbs may be placed on the occlusal surfaces of the molar teeth, but if so, they must be protected by a thick wrapping of gauze, or otherwise they may sustain injury when the jaws snap together.

**Reduction by Manipulation.**—It is not an uncommon occurrence for an anterior dislocation to become reduced spontaneously, and as Stimson points out, the most gentle methods that have been found successful are those which carry the condyle back through the positions it assumed while leaving the socket. Maisonneuve, in 1862, after a careful study concluded that muscular spasm and the resistance of the ligaments prevented the reduction, and that these could best be overcome by direct backward propulsion after opening the mouth more widely. The method is as follows: The spasm of the muscles should be overcome, either with the assistance of the patient or with the aid of an anesthetic; and the ligaments are relaxed by depressing the chin and pushing backward on the rami. The theory of this is: that as the chin is depressed the lower end of the ramus travels upward and backward, which relaxes the ligaments and disengages the condyle from the eminence. As the backward pressure on the ramus is continued, the head glides over the crest of the eminence, and the reduction is complete. In some cases, particularly of long standing, all methods short of cutting down upon the joint will fail.

**Retention.**—When the dislocation is reduced, means must be taken to prevent its recurrence. The head cannot become dislocated until it rises up on the eminence, which does not begin until the mouth is opened at least 1 centimeter. Restriction of motion can be brought about by the use of a head to chin bandage for three weeks. A very

much neater way is to band an upper and lower tooth, a canine or first premolar, and unite them with a strand of braided silk or strong elastic band that will allow the jaws to separate 1 centimeter. For an acute dislocation this must be worn for three weeks.

## UNREDUCED DISLOCATIONS

According to Stimson, the prognosis of an unreduced anterior dislocation is not bad. The condyle and ligaments adapt themselves to the new position. Reduction should even be attempted some time after the dislocation has occurred. If function is poor, the joint should be opened, the fossa cleared, and the condyle replaced. If this cannot be done, one or both condyles may be excised.

## CHRONIC DISLOCATIONS

If proper means are not taken to prevent its recurrence, a dislocation may become chronic, the condyles slipping forward at any time when the mouth is widely opened. For such a condition Annandale opened the joint and stitched the meniscus to the periosteum in two cases. We think a simpler method of treating such a condition is to limit the motion of the jaw, as described previously. We once had a patient wear this appliance for three months with good results.

## SUBLUXATION

It is not an uncommon condition for the condyle to catch every time the mouth is widely opened and to recede with a cracking sound, accompanied by pain. In older persons it may be due to an arthritis, but in young persons, with lax ligaments, it is in most cases either a subluxation or a catching of the meniscus. Besides general tonic treatment, the movement of the jaw may be limited until the ligaments regain a healthy tone. Ashhurst reports good results from opening the joint, and excision of the meniscus, and we have recently similarly treated such a case.

# CHAPTER XII

## INFECTIONS AND INFLAMMATIONS OF THE MOUTH

The mouth is subject to a great number of diseases, some of which are purely local, while others are local manifestations of a general disorder. Even among the diseases that are caused by local infections, there are very few but that are more or less dependent upon, or influenced by, the state of digestion or metabolism of the individual.

The close relation that exists between diseases of the digestive tract and irritations of the mouth is probably explained by the fact that toxins absorbed from the stomach and intestines are partially excreted in the saliva, and that much of the septic material of the mouth finds its way to the stomach and intestines.

It is not too much to assume that every disease has one or more specific causes. Those of which the cause is known are classified accordingly. At present there are still many diseases whose causes are not known, and these, like tumors, have to be classified according to their lesions and symptoms. This symptomatic arrangement is far from satisfactory, for sometimes the changing picture carries a case from one classification into another. The result is that in some instances a number of different affections are placed under the same heading, while in others the different clinical manifestations of the same disease are called by as many different names. This difficulty applies to the classification of the various forms of stomatitis. As an example, ulcerative stomatitis may be due to local causes or infection with particular organisms in the mouth, or it may be a manifestation of systemic poisoning with mercury.

In the following, all the commoner forms of stomatitis known to be due to a specific cause are classified accordingly, but the various recognized symptoms that appear without recognized cause, or which we know may be due to one or a number of causes, are classified according to the most prominent characteristic of the lesion.

First will be taken up those forms of stomatitis not due to any one specific cause, but which are characterized by a definite symptomatology. Then some of the commoner varieties of stomatitis of specific etiology will be described.

The following belong to the first group:

## 1. ACUTE CATARRHAL STOMATITIS

Under this head should be included all acute inflammations of the mouth, characterized by simple redness and soreness of the mucous membrane.

**Etiology.**—This may be due to irritation of erupting teeth, thermic or chemical irritants, spices, alcohol or tobacco, digestive disturbances. It may be a local manifestation of some general disease, drug or mineral poisoning, such as mercury, bismuth or iodin.

**Symptoms.**—As a rule, a dusky-red color precedes an indistinct grayish-white filmy discoloration due to cloudy swelling of the epithelium. After desquamation, the mucous membrane remains intensely red. The patient complains of discomfort, especially on eating hot or spiced foods, and this may be a reason for children refusing to eat or nurse. The sense of taste is diminished, and the tongue is furred. The flow of saliva is usually increased, but the mucous membrane may be rather dry. The whole mouth may be affected, or it may be limited to the gums or to some other part.

The **prognosis** will depend entirely upon the cause. Most cases heal quickly without treatment, while others go on to a chronic form. The latter are dependent upon some persistent defect in the digestion or metabolism, or some other continuous mild irritation. On the other hand, simple catarrhal stomatitis may be the forerunner of one of the more serious forms, and quickly undergo a change for the worse, due to involvement of the deeper tissues.

The **treatment** consists in control of the cause, abstinence from irritating foods, possibly the administration of a purge, attention to the digestion, and the use of some alkaline wash, such as the alkaline antiseptic solution.

In bottle-fed infants, special care should be given to the cleanliness of bottles and nipples.

## 2. APHTHOUS STOMATITIS

The **cause** of aphthous stomatitis has not been definitely settled. Some recognize it as a contagious disease, while others believe it to be due to a nervous or digestive derangement. It occurs both in children and adults, more often in the former. Aphthae appear as grayish white spots with a reddened border, circular or angular in outline, varying in size from a pinhead to a pea. They are found in various parts of the mouth, especially in the vestibule, on the

gums, lips, and under the tongue. The spots are usually scanty, but may be numerous and show a tendency to coalesce. The eruption is not vesicular, but is from the onset a fibrinous exudation, which is deposited within the epithelium itself. The plaques increase for the first three days and are accompanied by salivation and considerable pain. The neighboring lymph nodes become enlarged and there is a decided fetor to the breath. The exudate then shrinks and is discharged, leaving red spots, which gradually disappear, leaving no scar.

The **treatment** consists in fresh air, proper feeding, attention to the digestive tract, and the use of an alkaline antiseptic mouth wash. In persistent cases the spots should be touched with a 10 per cent solution of silver nitrate once or twice a day.

## 3. ULCERATIVE STOMATITIS

Ulcerative stomatitis occurs both in children and adults, and is often the result of unhygienic surroundings. It sometimes occurs in epidemics, or may simply represent a stage of stomatitis due to some specific cause.

**Symptoms.**—The mucous membrane of the mouth is very much inflamed, breaks down and leaves shallow ulcers covered with yellowish exudation. The breath is extremely fetid, and there is an excessive flow of saliva. The infection may spread to the sockets of the teeth, causing the latter to loosen and drop out. Fever and indigestion are often associated conditions. The submaxillary lymph nodes are enlarged and tender. Especially in children the general condition is severely affected, pain, fever, and lack of appetite being marked. If treated, the **prognosis** is good, but septic complications are possible.

**Treatment.**—Internally, potassium chlorate may be administered in the form of a solution for the first three or four days, three to five grains three or four times a day, but not continued on account of danger of renal irritation. The teeth and mouth should be mechanically cleansed by swabbing with hydrogen dioxid and the use of potassium permanganate, 1-3000 solution, as a mouth wash. The ulcers may be touched with 10 per cent silver nitrate, pure carbolic acid, or trichloracetic acid crystals. The application of powdered subnitrate of bismuth to the ulcers is often soothing. Fresh air is an important factor, and children should be kept in the open air, the beds being moved outdoors or next to an open window.

## 4. GANGRENOUS STOMATITIS

Gangrenous stomatitis is a further stage of ulcerative stomatitis in which the destruction of tissue extends deeper than the mucous membrane.

**Causes.**—It is seen in persons whose vitality has been much lowered, as through alcoholism, and who live amid poor hygienic surroundings and improper nourishment. These factors, in conjunction with lack of attention to cleanliness of the mouth and teeth, are responsible for the disease.

Fig. 90.—Sloughing through skin of chin, following gangrenous stomatitis.

**Symptoms.**—The disease starts as an ulcer, usually in the vestibule of the mouth, which becomes larger, the inflammation spreading to the deeper tissues, which slough, forming a foul, grayish-yellow stringy mass. The teeth become very loose and may be lost. The flow of saliva is increased, and the swelling interferes with speech and mastication. There is a great deal of pain. Marked constitutional symptoms sometimes are present, the result of absorption of toxic matter from the mouth. The temperature may reach 104°, and be accompanied with weak and rapid pulse. The gangrenous process may spread to the bone, may perforate the cheek or chin (Fig. 90), or the infection may pass into the deep cellular tissue of the neck and about the glottis, threatening suffocation of the patient.

The **prognosis** is unfavorable, probably about 50 per cent of the cases being fatal.

**Treatment.**—*Local* measures consist in keeping the mouth as clean as possible. The stringy necrotic tissue should be trimmed away with scissors once a day, and after swabbing the surface with cotton soaked in hydrogen dioxid, it may be touched with pure nitric acid, applied by means of a few threads of cotton wrapped on an orange wood stick. The patient should be given a mouth wash of 1-2000 solution of potassium permanganate, which should be used frequently throughout the day. *General Treatment.* Where constitutional symptoms are marked, the patient should have rest in bed. Stimulants and tonics are indicated. Ten or fifteen drops of tincture of chloride of iron and one thirtieth of a grain of strychnine four times a day are usually sufficient in the way of stimulation. The bowels should be freely opened with calomel in the dose of one-fourth of a grain every hour for four doses, followed by half an ounce of magnesium sulphate. The diet should be liquid at first, until the patient can chew and swallow solid food. As soon as possible the patient should be allowed to sit up, as the danger of necrosis is thereby lessened. A liberal amount of water should be given to favor elimination by the kidneys. In case of bone necrosis, removal of sequestra at the opportune time is indicated. Foci of suppuration in the neck and elsewhere should be opened and drained.

The following forms of stomatitis are due to specific causes:

## 1. ULCEROMEMBRANOUS STOMATITIS (VINCENT'S ANGINA, TRENCH MOUTH)

Ulceromembranous stomatitis is a form of oral and tonsillar infection which of late has attracted considerable attention. Under the name of trench mouth, it was one of the commonest affections of the troops during the World War. It is probable that the great majority of cases of ulcerative and gangrenous stomatitis formerly unclassified, really belong in this category.

**Etiology.**—The direct cause of the disease is the combined effect of a spindle-shaped or fusiform bacillus and a spirochete, described by Plaut and Vincent. Often these organisms have been found in the mouth as saprophytes. It is probable that, like many other organisms, they only become pathogenic under certain favorable circumstances. The disease often occurs in epidemic form, leaving no doubt as to its contagious nature. Epidemics are favored by crowding to-

gether of people, as among troops in barracks, the use of common drinking vessels, lack of fresh air and suitable food, and unhygienic mouths.

**The Organisms.**—The spirochete and the fusiform bacillus are always present in the lesions. The Bacillus fusiformis is a long slender organism with tapering or slightly pointed ends. It is nonmotile and Gram negative, staining unequally with aniline dyes, yielding a granular appearance. It can be cultivated by anaerobic methods. The spirochete is long, wavy, with much larger and fewer turns than the spirochete of syphilis. It does not stain as deeply as the fusiform bacillus. It is probable that these two organisms are different stages in the life cycle of the same organism, and not a true symbiosis. The local predisposing factors are general neglect of oral hygiene, faulty dentistry, irritation from eruption of teeth. The disease frequently begins in the gum flap overlying a partially erupted lower third molar, thence spreading to other parts of the mouth.

**Symptoms and Diagnosis.**—The gums are inflamed, painful, and bleed easily. The gum margins are thickened and drawn away from contact with the teeth. The edges of the gum are covered with a grayish white membrane, which when removed leaves a raw bleeding surface. There is progressive destruction of the marginal gum tissue, especially of the interdental septum, the alveolar process itself being eventually attacked. The teeth are tender to the slightest percussion and become loosened, being lost as the bone around them is destroyed. The breath has a characteristic foul odor, and there is a marked increase in the flow of saliva. The disease is not always limited to the gingivae, but may be found on various parts of the oral mucous membrane, including the cheek, the hard and soft palate, and the tonsils. The ulcers are covered with a grayish pseudomembrane due to necrosis of the superficial layers of the mucosa. The patient complains of great pain, headache, nausea, and there is generally a rise in temperature. The submaxillary lymph nodes are almost invariably swollen and tender.

Stained smears made from the lesions show microscopically a great preponderance of the fusiform bacilli and spirochetes.

**Treatment.**—Almost every writer on this subject advocates a different drug for local application in this disease, proving that there are many remedies useful for its control. There are certain underlying principles, however, that must be followed to insure successful treatment.

**Cleansing of the Mouth.**—Owing to the extreme tenderness of

the gums, the patient will not tolerate scaling or even moderate instrumentation of the teeth. This is also inadvisable in the acute stages on account of the danger of spreading the infection. However, as much as possible of the debris and slough should be gently removed by swabbing with cotton applicators soaked in hydrogen dioxid. The mouth is gone over thoroughly in this manner, the gums are then dried as well as possible, and the lesions are touched with some strong germicide, which in the individual experience of the operator has proved most efficacious. Many drugs have been used for this purpose, including 1 per cent mercuric cyanide, copper sulphate, methylene blue, gentian violet, and, on the theory of specific spirochetacidal therapy, arsenical preparations such as Fowler's solution (liq. potassii arsenitis), and 10 per cent solution of salvarsan in glycerine. We have found Talbot's iodoglycerol to be effective in a majority of cases. This consists of the following:

| | | |
|---|---|---|
| Zinc iodide | 15 | parts |
| Distilled water | 10 | " |
| Iodin | 25 | " |
| Glycerin | 50 | " |

The principal point to be observed is persistence in treatment. The local treatment at first is carried out two or three times daily, and then applied less frequently as improvement occurs. The patient should use a mouth wash of potassium permanganate, 1-3000 solution, at frequent intervals. Occasionally, cases resist all forms of local treatment, and the intravenous administration of arsphenamine is resorted to. Cure is determined by clearing up of the symptoms and the obtaining of a negative microscopic smear. As soon as the local condition permits, scaling of the teeth, extraction of decayed roots and hopelessly loosened teeth, and filling of carious cavities are carried out. General treatment consists in keeping the bowels open, possibly the administration of anodynes to relieve pain, and careful attention to the diet. Fresh fruit juices and green vegetables should be given liberally. By these methods, the great majority of cases clear up in four to seven days.

## 2. NOMA, OR CANCRUM ORIS

Noma is a progressive gangrene of the mouth, which is most apt to occur in children, especially between the ages of three and twelve years. It is most frequently seen in debilitated subjects and often

follows some infectious disease, such as measles or whooping cough. There has been some evidence presented to suggest that noma is due to blocking of the circulation by invasion of the tissues with Vincent's fusiform bacillus and spirochete.

**Symptoms.**—Noma has been observed to originate in an indurated spot, usually near the lips, or on the gum over the alveolar process. This becomes dark, soon softens and breaks down. The ulcer spreads, and sooner or later it involves the full thickness of the cheek. The jaw bone may be exposed. The tissue of the cheek becomes black, and finally sloughs away, exposing the mouth. There is extreme fetor of the breath and salivation is marked. The lymph nodes are involved early, the temperature is high, the pulse weak and rapid, and death from sepsis or pneumonia usually results in a few days. When death does not result, the scarring will be proportionate to the extent of tissue destruction.

**Treatment.**—The whole diseased area should be destroyed well into the healthy tissue with the actual cautery, and to the remaining surface may be applied nitric acid on an orange wood stick, this being repeated frequently. The general condition of the patient requires stimulation. If the child survives, plastic operations will usually be necessary later to repair the defect left by the disease.

## 3. THRUSH

Thrush is a parasitic form of stomatitis, caused by growth of the fungus, *oidium albicans,* which is most commonly found in the mouths of unhealthy, unclean infants. Its favorite sites of onset are the anterior part of the tongue, the gums, and cheeks. It thrives best in infants who receive starchy foods. It is very contagious and spreads easily by the use of unclean nipples, pacifiers, etc. Thrush often occurs in the mouths of infants with cleft palate.

The disease first begins by the appearance of pinhead white spots that spread and unite, forming patches. The patches cannot easily be removed, for the fungus grows not only on the surface, but into the epithelium and underlying connective tissue. When torn off, the patch leaves the underlying mucous membrane red, softened and bleeding easily. After persisting some time, the color of the growth becomes yellow or brownish and scales off easily. The onset of the disease is painless and therefore often overlooked. If it has not preceded the infection, gastrointestinal disturbances are likely to follow, high fever may be present, and soreness may interfere with

feeding. The growth usually responds quickly to treatment, but sometimes recurs rapidly.

The diagnosis of thrush rests upon the appearance and growth of the patches, and the fact that they are in the early stages removed with difficulty and at once recur. From aphthae they are clinically distinguished by their color, which is at first dead white, and by the fact that the growth of thrush has an uneven surface and is elevated above the surface of the epithelium. The diagnosis can be made absolutely certain by a microscopical examination of the membrane, which shows the specific fungus.

**Treatment** consists partly in general care of the patient, fresh air, clean utensils and avoidance of starchy foods. Many clinicians claim that boric acid holds first place as a local application. In infants this is safely applied by means of the boric acid teat of Esmarch, which consists of a compressed pad of absorbent cotton impregnated with powdered boric acid. The pad, which should be about one and a half to two cm. in diameter, is covered with cotton cloth and then dipped in a solution of glycerin and water. As the infant champs and sucks the teat the mouth is mechanically cleansed, and the boric acid is distributed.

## 4. FOOT AND MOUTH DISEASE

Foot and mouth disease usually appears in epidemic form, and it has been shown that there is a direct connection between this disease in man and cattle. It is caused by the bacillus of Siegel. The characteristics of onset of the disease are fever, nausea and anorexia. There is a superficial inflammation affecting especially the tongue,—the rest of the mouth, pharynx and nose to a lesser extent. Small vesicles form on the lips, gum and tongue, seldom on the pharynx or palate. The vesicles are at first clear, but later become opaque. When the vesicles burst, there are left behind dusky, superficial ulcers or erosions. There is salivation and pain on eating. Diagnosis is confirmed by finding the bacillus of Siegel in the lesions.

**Treatment.**—The most important point in treatment is prevention. The disease is transmitted both by the milk of infected cows and by contact. The mouth should be kept clean, 1-3000 potassium permanganate solution used as a mouth wash very frequently. The separate vesicles may be painted with a 3 per cent solution of phenol. The general care of the patient should receive careful attention, for the disease is often fatal.

## 5. TOXIC STOMATITIS

The two most common minerals producing a toxemia with mouth symptoms are mercury and bismuth.

(a) **Mercurial stomatitis** is an inflammation of the mouth due to the continued administration of small doses or the ingestion of large doses of mercury. It is also seen in artisans who work in mercury, the poison gaining entrance through the digestive or respiratory tracts. Among those especially exposed to industrial mercurial poisoning are those working in mercury mines and makers of mirrors. With the introduction of better hygienic conditions and appropriate preventive measures, the occurrence of mercurial poisoning in connection with trades has greatly decreased. One case has been recently seen in a man who made dental amalgam alloy, which required the addition of a certain amount of mercury while the alloy was in the molten state. He had to stand over the crucible during the process and was thus forced to inhale the fumes of the mercury.

Inflammation of the gums is not produced by the direct action of the mercury upon the oral mucous membrane, but the poison enters the blood via the gastrointestinal or respiratory tracts or skin, lowers general vital resistance, thus permitting the growth of pathogenic bacteria within the mouth. Mercury is not excreted in the saliva. Patients taking mercury whose mouths have been previously put in hygienic condition and are kept clean very rarely get mercurial stomatitis.

**Symptoms.**—The trouble starts with tenderness of the gums and pain on bringing the upper and lower teeth together. The gums around the necks of the teeth are reddened. There is an increase in the flow of saliva (ptyalism or salivation). Later, the salivation becomes profuse, there is an intense fetor of the breath, and the gums become much swollen and of a dark red color. The teeth loosen and may be lost. In severe cases ulceration of the gums and necrosis of the alveolar process may result. Among general symptoms are diarrhea and anemia.

**Treatment.**—The condition can generally be prevented by appropriate prophylactic treatment before putting a patient on a course of mercury and by careful watch for the earliest signs of the onset of poisoning. Before administering mercury, when the drug is to be administered for any length of time, the mouth should be put into a thoroughly hygienic condition. All deposits should be removed from the teeth, cavities filled, and useless roots extracted. During the

entire course of treatment by mercury a mouth wash should be used, and the teeth kept thoroughly clean. If the slightest tenderness of the teeth on bringing them together occurs, reduce the dose of mercury to one-half, and if the symptoms do not subside, discontinue the mercury altogether for a time. If the case is one of industrial stomatitis, the patient should immediately discontinue his work. The mouth in all cases must be thoroughly cleaned, as in the case of prophylactic treatment. The inflamed gums may be touched once daily with Talbot's iodoglycerol. The best mouth wash is a 1-2000 solution of potassium permanganate. Potassium chlorate, 10 grains to the ounce of water, may also be used as a mouth wash. Potassium iodide in 10 grain doses may be given internally to aid in elimination of the mercury.

(b) **Bismuth poisoning** may produce a stomatitis with symptoms almost identical with those of mercurial stomatitis. We note the tenderness of the teeth and gums, the salivation, loosening of the teeth, ulceration of the gum tissue. The principal difference is that in bismuth poisoning the gums have a black discoloration instead of being red. Bismuth poisoning sometimes follows the injection of large amounts of subnitrate of bismuth paste in the treatment of chronic suppurative conditions.

The **treatment** is the same as in mercurial stomatitis.

(c) **Lead poisoning**, while not in itself producing a stomatitis, manifests itself in the mouth by the presence of a bluish-black line in the edge of the gum near the necks of the teeth. This is a very valuable sign of lead poisoning if not confused with conditions that resemble it. The black deposit is the sulphide of lead, and is distinguished from discolored tartar by the fact that it cannot be scraped off. It is aggravated by the existence of gingivitis due to tartar, but may be found also in a comparatively clean mouth. Lead poisoning also produces gastrointestinal symptoms—colic and constipation, cerebral symptoms—convulsions, and nervous symptoms—wrist drop and other paralyses. Besides this, the blood examination shows a secondary anemia, together with basophilic degeneration and stippling of the red cells. By this is meant the presence of fine blue-staining granules in the pink staining red cells. It is interesting to study the various sources from which lead gains entrance to the system. Lead poisoning is common in persons working at trades involving the use of lead compounds, particularly lead smelters, makers of white-lead for paint, potters, who use lead in glazing, storage battery makers, and painters. Lead may also enter the sys-

tem through drinking water conveyed through lead pipes, through hair dyes, drugs, and cheaply canned food.

There are certain diseases of the blood which manifest themselves by oral mucous membrane symptoms. *Hemophilia* is due to a deficiency in the substances that produce coagulation of the blood. It is characterized by spontaneous hemorrhages from mucous membranes, among others being that of the oral cavity. Another blood disease similar to hemophilia is *purpura hemorrhagica*, characterized by the rupture of small blood vessels with the formation of hemorrhagic patches under the skin or mucous membranes, sometimes manifested in the mouth.

**Leukemia** is the term given to a group of diseases of the blood-forming organs in which there is an enormous over-production of certain forms of leucocytes, and enlargement of lymph nodes, spleen, and changes in the bone marrow. Mouth symptoms are sometimes found in lymphatic leukemia. These are swelling and ulceration of the mucous membrane of the gums and palate, accompanied by bleeding, without any obvious local cause, and which resist all forms of local treatment. This is an extremely fatal disease, and though not common, it may fall to the lot of the dentist to be the first to see the case on account of the mouth symptoms. From the foregoing it is readily understood that many lesions of the oral mucous membrane are not only local in character, but may be manifestations of widespread and serious systemic disease, and of great diagnostic importance.

**Scurvy** is a nutritional disease due to deficiency of certain vital principles in the food, to which the term vitamines has been applied. The particular substance whose absence in the diet causes scurvy is known as the antiscorbutic vitamine, and is found in certain fresh fruit juices, such as orange and lemon, and in some green vegetables. Among the chief symptoms of scurvy are gingivitis, bleeding of the gums, and in severe cases sloughing, gangrene and necrosis. Deficiency in the diet of antiscorbutic elements may predispose to infection with Vincent's organisms.

# CHAPTER XIII

## INFECTIONS OF THE TEETH AND PERIAPICAL TISSUES

Chronic oral infections are now recognized as the cause of many serious disabilities. About 75 per cent of adults have been shown to have infections about the teeth which have destroyed enough of the bone to be easily demonstrable by radiographic examination (Arthur D. Black: Roentgenographic and Microscopic studies of tissues involved in Chronic Mouth Infections, Journal A. M. A., 1717, lxix, 599). Miller (W. D. Miller: The human mouth as a focus of infection, Dental Cosmos, 1891, xxxiii, 689) called attention to the relationship of mouth infections to systemic disease in 1891; Hunter (William Hunter: Role of sepsis and antisepsis in medicine, Lancet, London, Jan. 14, 1911) declared in 1911 that oral sepsis was a most prolific cause of serious secondary effects; studies by Billings and Rosenow of focal infections in general and by Gilmer (Thomas L. Gilmer: Chronic oral infections, Illinois Medical Journal, 1912, xxi, 275) and others of the oral infections in particular, demonstrated what Hunter had observed clinically. It is therefore important that careful inquiry be made of the causes which lead to the establishment of these mouth foci and the means by which they may be prevented or eliminated. This requires an understanding of the peculiarities of the tissues involved, especially the peridental membrane.

**The bones** of the jaw differ in no essential from bones composing other parts of the skeleton, and they are subject to the same diseases; but from environment, and possibly from other causes, are more prone to some, and less so to other, pathologic processes.

The body of the lower jaw has an outer thick wall composed of hard, compact bone, and contains cancellous bone and a large open canal which carries the nutrient artery and inferior dental nerve. During the period of growth, the neck is separated from the condyle by an epiphyseal cartilage, so that the mandible is a true long bone with a diaphysis and two epiphyses. The bodies of the maxillae are of less compact bone, and the dental nerves occupy several small canals. The alveolar processes are composed of bone which is almost cancellous, except that the thick outer plates of dense bone of the mandible cover these processes also. Many minute foramina pene-

trate the outer plate of the alveolar process of the upper jaw, but there are very few in the lower, being confined almost entirely to the crests of the septa between the teeth. The jaw bones are covered with periosteum, which dips into the tooth sockets lining each completely and furnishing an attachment for the fibers of the peridental membrane, which connect the alveolar periosteum with the cemental covering of the roots of the teeth.

The **cementum** is a specialized tissue, closely analogous to subperiosteal bone, but different in that it has no circulation of blood. The cementum is of itself an entirely passive tissue, and when stripped of the overlying soft tissue, it dies just as subperiosteal bone dies when pus lifts the periosteum away from it. Since there is no circulation of blood in the cementum, the dead portion cannot be exfoliated, as is a piece of necrosed bone. Practically all cases of chronic mouth infection are due either to lesions at the apices of roots or to pus pockets along the sides of the roots, and in both the necrosed cementum is the tissue responsible for the maintenance of the chronicity. When the peridental membrane has been detached from the cementum by suppuration, it does not become reattached, partly because the specialized elements of the peridental membrane—the cementoblasts and the principal fibers that extend from alveolar process to the tooth root, and which are necessary to a normal reattachment—have been destroyed, and partly because of the changed nature of the cementum itself. The absorption by the cementum of the products of the suppurative process renders it non-chemotactic.

The **peridental membrane** is the tissue which fills the space between the tooth root and the surrounding bone of the alveolar process; and also covers the root beyond the crest of the alveolar process as far as the junction of the root and the crown of the tooth. This membrane is made up of principal fibres, ordinary connective tissues, cementoblasts, osteoblasts, blood vessels and nerves. The principal fibers either connect the cementum with the bone of the alveolar process, or pass directly across over the crest of the alveolar septa from tooth to tooth, or pass outward from the cementum into the soft tissue about the neck of the tooth. These fibers serve to cushion the tooth against the stress of mastication and to support the gingivae, causing the latter to hug tightly about the teeth. The root ends of these fibres are embedded in the cementum, and the cementoblasts lie on the surface of the cementum between the fibers; in the same manner the other ends of the fibers which pass to the bone are embedded in it, the osteoblasts occupying the space between them. The

peridental membrane is peculiarly well supplied with blood, some vessels entering this tissue at the root apex, others over the crest of the alveolar process, and still others passing directly through the surrounding bone.

The **mucous membrane** lining the mouth is closely adherent to all bony parts. That covering the alveolar process is termed the gums. The epithelium of the gingivae is thicker and the cells are more closely packed than elsewhere in the mouth. Many long legs of connective tissue, with blood vessels, project far into this gingival epithelium. It will thus be noted that the gingivae are adapted for hard usage and quick repair, so that they can withstand the wear and tear of mastication. The gingivae stand as protecting tissues to the deeper seated peridental membranes.

We may look upon the mouth as a machine which has been especially adapted for the performance of its function of mastication of food, and subject to many injuries and much wear and tear. The hard enamel of the teeth not only performs its principal function of biting and crushing, but also protects the dentine and pulp from injury and irritation. The gingivae must also withstand much irritation and suffer many slight injuries, which they are exceptionally well prepared to do by the denseness of their structure and the provision for quick repair. Thus they protect the peridental membrane.

Chronic foci of infection in the mouth may become established as a result of an initial injury or break in either of these protective tissues. The enamel may be penetrated by dental caries, and if neglected, the case progresses until the pulp tissue becomes inflamed and dies; infection of the pulp tissue occurs and may involve the tissues about the root apex. Or the gingivae may, as a result of irritation or injury, become infected and this may gradually involve and destroy the peridental membrane. The one route is through the tooth to the tissues at the root end, the other is along the outside of the root. In both, the destructive processes include the peridental membrane, the bone of the alveolar process and the cementum covering the root of the tooth.

## ACUTE DENTO-ALVEOLAR ABSCESS

A dento-alveolar abscess is always a sequela of the death of the pulp of a tooth. Usually the pulp becomes inflamed and dies as a result of its exposure by dental caries. Occasionally a pulp will die as a result of a blow or other injury to the tooth, there being pos-

sibly no cavity in the tooth. In one case the pulp tissue may be infected directly from the mouth, and in either the infection may be brought by the blood stream. The infection passes through the foramen at the end of the root, involves the periapical tissues, and thus develops an alveolar abscess.

The acute dento-alveolar abscess may be primary or secondary. It is primary when it immediately follows infection of the peridental membrane by passage of bacteria from the pulp chamber through the apical foramen. It is secondary when it occurs as a flare-up in a case of long-standing chronic periapical disease.

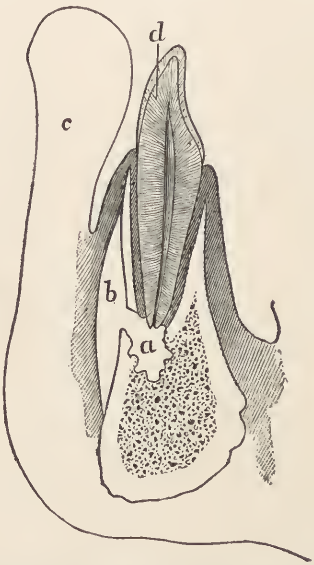



Fig. 91.—Sketch illustrating case of acute alveolar abscess from a lower incisor tooth in which the pus has lifted the periosteum from the labial plate of bone, but has not penetrated the periosteum. *a*, abscess cavity at apex of root; *b*, pus lying between the periosteum and bone; *c*, lower lip; *d*, tooth.—*G. V. Black.*

Acute dento-alveolar abscess is accompanied by all of the symptoms of acute inflammation, the pain often being especially severe, because of the confinement within the bone. The pus will usually burrow its way to the surface of the bone, more often to the labial or buccal side, and penetrate the outer plate, almost directly opposite the apex of the tooth which is abscessed (Fig. 91).

There are many variations of the routes along which pus may burrow. In the upper jaw, from the premolar and molar teeth, it may penetrate the floor of the maxillary sinus; from the incisors, the discharge may be through the floor of the nose. Occasionally

it will reach the periosteum above the attachment of the buccinator muscle and will then discharge through the cheek, or if above the nasal muscles it may discharge in the region of the inner canthus of the eye. From the lower teeth, the exit of pus from the bone on the lingual side below the attachment of the mylo-hyoid muscle may result in much swelling of the floor of the mouth; if the abscess is from the molar teeth, it may find its way under the deep fascia and follow the sternocleidomastoid to the clavicular region. One case has been seen recently in which the abscess opened on the chest below the clavicle.

In the diagnosis of acute dento-alveolar abscess it is importnt to determine the tooth or teeth involved. The swelling and other symptoms of inflammation will usually be localized around an obviously devitalized tooth or broken down root. If there is a sinus discharging into the mouth this will usually be close to the root of the offending tooth. The tooth may be loosened from infection of the peridental membrane. In primary acute dento-alveolar abscess, x-ray findings may be negative, because the inflammation will not have been of sufficient duration for bone destruction or rarefaction to have occurred. In the secondary acute abscess the radiograph will as a rule show evidence of more or less extensive bone destruction about the root apex and thus serve to point out the etiologic factor.

**Treatment.**—Since most serious infections of these tissues originate in the field of the dentist, it is important that every possible effort be made to cut these cases short before the peridental membrane becomes involved. Dental caries must be prevented or so treated that there will be the highest possible degree of pulp conservation. This calls for the closest cooperation between patient and dentist; better care by the patient, more frequent and more thorough examinations to find cavities when small, and the greatest care in the technic of filling operations.

An acute alveolar abscess calls for the same treatment as any other abscess—good drainage for the discharge of pus and to relieve the pain. As soon as pus can be palpated an incision should be made to evacuate it. As a rule the incision should be made within the mouth. If it is to be made on the lingual aspect of the gum, posterior to the premolar teeth, the point of the knife should be inserted and kept close to the bone on account of the proximity of the lingual nerve. The incision should be made parallel to the alveolar process, with the knife held obliquely so that the point will cut through the periosteum. The center of the incision should be over the point of greatest tender-

ness. The incision must cut through the periosteum, for the pus is at first subperiosteal and can remain so until great damage is done to the bone. If the pus is not seen to flow after this incision, the knife is to be reinserted at the middle of the wound with the edge toward the bone, and the periosteum incised from the lower to the alveolar border of the jaw. It is not probable that both cuts of this crucial incision will miss a subperiosteal focus, but it does not necessarily follow that visible pus will be liberated. The swelling may be entirely an induration. As sharply outlined, well-marked indurations are often caused by the more virulent staphylococcus and streptococcus infections, it is important that these be freely drained, for any one of them may be an early stage of fulminating infection. The majority will subside without causing serious trouble, but it is a safe rule to incise every such induration, unless seen late when the symp-

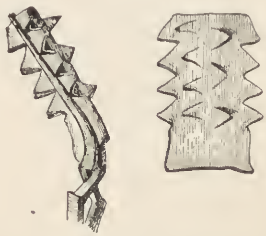


Fig. 92.—Showing one method of cutting and inserting a self-retaining rubber dam drainage.

toms are subsiding. Usually a well executed incision will initiate convalescence, though it may be followed by some reaction, and occasionally the infection will continue to spread in spite of drainage. After the opening is made, a self-retaining rubber dam drain may be carried to the bottom of the wound; and if pain, induration, or fever persist, hot applications in the mouth should be used frequently. (Fig. 92.) The immediate after-treatment consists further in the use of a weak solution of potassium permanganate, or any mildly antiseptic mouth wash. If the rubber dam reaches to the bottom of the wound, other local treatment will be unnecessary. However, if the wound is foul, it may be irrigated, and lightly packed with gauze saturated with compound tincture of benzoin. If there is dead or diseased bone or a piece of root exposed in a bone cavity, it is probable that a sinus will persist (Fig. 93). Where the offending tooth is worth saving, persistence or recurrence of the infection may be avoided by cleansing, sterilization and filling of the root canal. If

the tooth is not worth saving, it should be extracted. Judgment should be exercised in choosing the time for extraction. There is considerable hesitation in some quarters about the extraction of teeth in cases of acute abscess, because frequently, where rapid extension of an infection has followed the extraction of a tooth, the dentist has been blamed on the theory that his instruments were not clean. There is no more justice in this than to conclude because a peritonitis follows an appendectomy it was due to infection introduced at the operation. The infection from a tooth root spreads from near the apex of the socket, a part rarely directly reached by the beaks of the

Fig. 93.—External sinus persisting after acute dento-alveolar abscess.

extracting forceps. Both the appendix and the tooth are removed because they are diseased, and the diffuse infection that may result is, in either case, due partly to trauma of the operation and partly to a lack of resistance to the infection. If in the presence of disaster any blame is to be attached to the operation, it should usually be placed upon the time that it was chosen. In the early stage of pus formation, before the limiting line of leucocytes has fully formed, there is some justification for delay in extraction of the tooth until the natural barrier has been established. But in the presence of free formation of pus it is seldom that a case is not immediately benefited by extraction of the tooth.

An attempt should always be made to prevent the pus of a dento-alveolar abscess from pointing externally on the face or neck. This may be often attained by early incision in the mouth, by the avoidance of hot poultices or hot water bags on the face, and by the application of cold and pressure externally. If the case is seen late, and external pointing is inevitable, cosmetic considerations must give way to regard for the safety of the patient. An incision should be made large enough to thoroughly evacuate the pus. It should be made if possible at the most dependent portion of the abscess, so that gravity will aid in drainage. Disfigurement is minimized by cutting in the direction of the muscle fibers covering the region rather than cutting across them. In this way the wound edges do not gape so much and a smaller scar will result. A point, too, should be selected if possible in a natural fold of the skin or where the scar will be least noticeable, as under the lower border or behind the angle of the jaw. For drainage in these incisions, a strip of rubber dam or a rubber tube is suitable.

Where the acute dento-alveolar abscess is secondary to a chronic infection, after treatment and subsidence of the acute condition, the underlying chronic bone pathology must receive attention as outlined in dealing with chronic periapical infections.

Nitrous oxide is the anesthetic of choice in operating on acute abscesses, first, because of the inefficiency of local anesthetics in the presence of acute inflammation and secondly because of the danger of injecting into acutely inflamed tissues.

## CHRONIC PERIAPICAL INFECTIONS

**Pathology.**—In the vast majority of cases of this type, the disease results from infection following death of the dental pulp, the causative bacteria passing up the root canal and gaining access to the periapical tissues through the apical foramen of the tooth. This infection may follow dental caries and inflammation and death of the pulp, traumatism, or deliberate devitalization by the dentist. The use of arsenic for pulp devitalization, and the forcing of strongly irritating medicinal agents such as formaldehyde into the tissues are important factors in leading to infection. Failure on the part of the dentist to observe strict asepsis in performing root canal operations has been a frequent means of introducing streptococci from the mouth surface into the periapical tissues. The original infection in practically all cases of periapical disease is streptococcal. In case the invading

organism is of the nonhemolytic type, of low virulence, the inflammatory reaction is apt to be chronic, giving rise to little apparent disturbance, but slowly progressive and proliferative in nature. The first change occurring in the apical peridental membrane is a *thickening* of this tissue, which is infiltrated with various blood elements, but especially with polymorphonuclear and small round leucocytes, particularly the latter. This stage may be termed *chronic proliferative pericementitis.* This thickening of the peridental membrane takes place at the expense of the bone of the alveolar process, and as

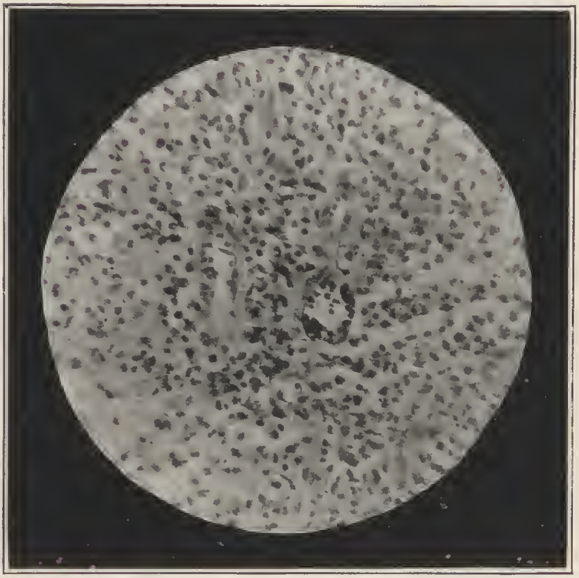


Fig. 94.—Chronic type of periapical inflammation. Preponderance of small round cells. Capillary blood vessels are seen, establishing a connection between the focus of infection and the general circulation.

proliferation of round cells occurs, the bone becomes rarefied and finally destroyed *(chronic rarefying osteitis)*, leaving a space filled with a mass of chronic inflammatory granulation tissue, the so-called *granuloma.* The granuloma is composed of small round cells, polymorphonuclear and endothelial leucocytes, fibroblasts, capillaries, and fibrous tissue, and sometimes masses of epithelial cells, to which attention will be called later (Fig. 94). From this tissue streptococci may be obtained both by direct smear and by culture. Sometimes the granulation tissue breaks down, and is replaced by fluid pus which fills the bone cavity or may discharge through a sinus *(chronic ab-*

*scess),* or the contents may consist partially of pus and partially of granulation tissue (suppurating granuloma). In the suppurative cases a secondary staphylococcic infection has usually been superadded to the original streptococcus. Lesions containing fluid pus, however, are in a minority, as compared to the granuloma, and therefore the term "chronic abscess" is entirely inapplicable to the great majority of cases of periapical infection. These areas of bone rarefaction and destruction may vary greatly in size. The bone absorption is usually accompanied by a slow detachment and destruction of the peridental membrane covering the cementum at the root end, thus depriving the latter of its blood supply, and converting it into a necrotic foreign body.

Coincidental with the chronic abscess or granuloma formation, rarefaction and absorption of the necrotic cementum of the root apex may take place. This is often accompanied by the production of new cementum by cementoblasts that have not been destroyed, forming irregular thickenings of the root. It occasionally happens in the process of repair that the bone cavity occupied by a granuloma becomes obliterated by this process of hypercementosis rather than by new bone formation.

An important fact from the clinical standpoint is that the contents of the spaces produced by periapical bone absorption, including bacteria and their products, are directly connected with the circulation through blood vessels and lymphatics in the walls of the cavities and running in all directions through the granulation tissue. While the outer layers of the granuloma may be denser and more fibrous than its inner portion, tending to retard *local* spread of infection, there is no limiting membrane in the sense of preventing its contents from entering the general circulation and being deposited in distant structures of the body.

### Cyst Formation

Among the connective tissue elements of the inflammatory granuloma developing as a result of infection about the root apex are frequently found masses of squamous epithelial cells (Fig. 95). Similar cells are present normally in the peridental membrane, where they are known as the paradental epithelial cell-rests of Malassez. These epithelial cells are believed to be the remains of the outer cells of the enamel organ which originally passed down and formed the outer wall of the sac in which the cementum of the tooth root was formed.

Fig. 95.—Mass of squamous epithelial cells (debris epitheliaux paradentaires) embedded in chronic periapical inflammatory tissue.

Fig. 96.—Early stage of cyst formation, showing cavity lined with several layers of epithelium, with chronic inflammatory tissue at the periphery.

Proliferation of these epithelial cells found among the granulation tissue is stimulated by the chronic inflammatory process. The mass of epithelium then breaks down in the center, and a space is formed containing fluid (Fig. 96). This cyst cavity gradually enlarges, pressure of the fluid causing atrophy of the epithelial cells and surrounding granulation tissue with enlargement of the bone cavity, until eventually the walls of the cyst are composed of a dense fibrous capsule lined at most with a few layers of epithelial cells. All traces of epithelium may finally disappear. The cyst fluid is usually clear, straw colored, and may contain cholesterin crystals. The fluid may be sterile, but infection of the cyst wall frequently converts it into pus. These dental root cysts vary considerably in size, from that of a small pea to a hen's egg. In the maxilla they may push up the floor of the maxillary sinus or the nasal fossa, but rarely actually open into these cavities.

The principal stages of chronic periapical disease may therefore be summed up as follows:

1. **Chronic proliferative pericementitis,** producing a slight thickening of the peridental membrane about the tooth apex, but without appreciable loss of bone. The treatment of this stage is as a rule nonsurgical.

2. **Chronic rarefying osteitis with granuloma.** A slow disintegration of bone takes place in a circumscribed area about the tooth apex, the bone tissue being replaced by granulation tissue. The tooth apex may project into the bone cavity, may be shortened or roughened from irregular absorption of the cementum, or may present enlargements due to hypercementosis.

3. **Chronic rarefying osteitis with suppuration, or chronic abscess.** Here we have an area of bone destruction in which the space is entirely or partly filled with fluid pus, which may or may not discharge through an opening on the gum. The apical peridental membrane is nearly always destroyed, the root end roughened, and the necrotic cementum bathed in pus. The infection in this type of lesion is to be regarded as more active than in the preceding form.

4. **Chronic rarefying osteitis with cyst formation.** This stage succeeds that of granuloma, the cavity in the bone being filled with clear fluid and often little soft tissue except a thin fibrous sac.

The process of rarefying osteitis with granuloma, suppuration or cyst formation frequently continues in the jawbones long after removal of the teeth through which the infection was originally introduced.

**Diagnosis.**—The diagnosis of chronic periapical disease processes depends upon the history, the symptoms, the clinical examination and the radiographic examination. Errors in diagnosis are frequently observed due to lack of coordination of these various factors, or failure to correctly interpret radiographic findings. Chronic periapical lesions often occur in the absence of clinical signs and symptoms, when radiographic examination becomes the principal means of diagnosis. Even in the absence of symptoms a periapical rarefied area as shown in the radiogram does mean usually that disease of some kind is present, unless the exposure has been made shortly after operation before the area has had time to become obliterated. The claim has been made that these areas of rarefaction shown by the x-ray are non-infective in the absence of pain and local symptoms, and may simply represent the results of previously existing disease that has been cured, in other words, that they contain harmless scar tissue. While conceding this possibility in a small number of cases, it is logical to believe that the persistence of such a rarefied area for any length of time without decreasing in size is sufficient evidence that a disease process is going on, otherwise the area would gradually become smaller and be replaced by new bone. There is abundant postoperative evidence that these areas of rarefaction disappear and are replaced by new bone unless infection remains. Postoperative pathologic findings (smears, cultures and tissue examinations) so strongly support the view that these rarefied areas shown by the x-ray are active foci of disease in most cases, that in our opinion it is the wisest course to regard them as diseased until proved healthy, especially in invalids, as it is a much more serious matter to leave a potential source of systemic infection than to sacrifice a possibly healthy tooth.

*Diagnosis of Granuloma.*—The pulp of the tooth will be absent or devitalized. There may be a history of trauma, or of dento-alveolar abscess. The tooth may be tender to pressure. Examination may show the scar of a healed sinus on the gum, or a distinct swelling and reddening may be observed in the apical region. There may be no symptoms or clinical signs, the diagnosis in this case being based on the radiographic findings of a more or less clearly defined small area of lessened density of the bone about the tooth apex, and possibly irregularity of form of the apex (Fig. 97). All of these symptoms and signs of bone pathology may be found in a portion of the mouth from which a tooth has been lost a varying length of time previously (Fig. 98).

*Chronic Abscess.*—Again the pulp of the tooth will be absent or devitalized. All symptoms may be absent, but the radiograph may

Fig. 97.—Radiogram showing apical granuloma, about upper lateral incisor.

Fig. 98.—Radiogram showing residual granuloma in lower molar region.

Fig. 99.—Chronic abscess about premolar teeth.

show a blurred periapical area of somewhat lessened density compared with the surrounding bone, with irregular and ill-defined margins, into which the roughened tooth apex projects (Fig. 99). Some-

times radiographic findings are inconclusive, and the only diagnostic feature is a flow of pus into the canal of the tooth upon drilling into it. On the other hand, the tooth may be tender, there may be a swelling about the apex, or a sinus discharging pus on the gum or even on the skin of the cheek or beneath the border of the jaw.

*Cyst Formation.*—The symptoms and history in the presence of a small dental root cyst may be exactly the same as those of granuloma,

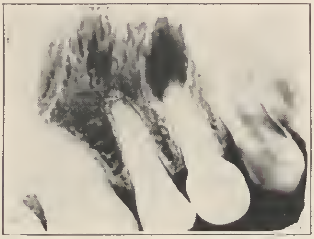


Fig. 100.—Small dental root cyst.

Fig. 101.—Large dental root cyst in upper anterior region.

or symptoms may be absent. The radiograph will show a very clearly defined dark area involving the apices of one or more teeth or on a part of the bone from which teeth have been extracted. The margins of the area are very regular and sharply defined, so that there is usually no difficulty in pointing out exactly where the healthy bone ends (Figs. 100, 101 and 102). In the case of a larger cyst, there is a history of a gradually increasing swelling, usually painless, with discharge of clear fluid into the mouth from time to time. Examina-

tion will show a swelling in the apical region of a pulpless tooth or location from which a tooth has been lost, which may extend over several teeth, with a thin, celluloid-like outer wall which can be pressed in with the finger, and which when punctured gives a clear serous or mucous fluid. Shiny cholesterin crystals may be present. Infection may give the fluid the character of pus.

**Treatment.**—The treatment of granuloma, of chronic abscess, and of dental root cyst is surgical eradication, together with removal of the associated diseased tooth structure. In the early stages of granuloma, there is a possibility of restoration to normal by treatment through the root canal, without surgery. The form the surgical treatment shall take, depends, not so much upon the particular type of

Fig. 102.—Large residual cyst arising from upper lateral incisor lost some time previously.

lesion present, as upon its extent and upon the amount of involvement of peridental membrane and necrosis of the root of the tooth, the position of the tooth in the mouth, its value to the patient, and the general systemic condition. The question of conservative or radical treatment of teeth showing periapical involvement should first of all be decided by the general health of the patient. Our attitude toward suspected teeth in patients who have some systemic condition in which mouth infection is possibly playing a part should be much more radical than that adopted in patients having no physical ailments. Conservative treatment of the tooth may often be attempted in healthy individuals, where in an invalid a tooth so affected would be removed without hesitation. So far, no reliable or satisfactory preoperative

pathologic means of proving the connection between suspected peridental areas and systemic conditions have been discovered, so at present we must take the risk of occasionally sacrificing a harmless tooth, which is a small matter when weighed in the balance against the general health of the individual.

*Indications for Various Forms of Treatment.*—In general, one of three courses of surgical treatment is to be adopted in these cases:

(1) Extraction of the tooth or teeth involved, with surgical eradication of the diseased periapical area.

(2) Preliminary sterilization and filling of the root canal, followed by removal of the necrotic end of the root (root resection), and surgical eradication of the diseased periapical area.

Fig. 103.—Lateral perforation of root by post of crown.

Fig. 104.—Lower molar with large suppurating periapical area and absorption of roots.

(3) Preliminary sterilization and filling of the root canal followed by surgical eradication or drainage of the diseased periapical area.

The various types of cases in which treatment under each of these headings is indicated will now be taken up in detail.

(1) *Extraction of the tooth or teeth involved, with surgical eradication of the diseased periapical area.* Under this heading fall cases showing the following conditions:

(a) Teeth with large periapical areas of granuloma, suppuration or cyst, in which more than one-fourth of the peridental membrane

has been lost, and in which the cementum is eroded and absorbed (Figs. 97, 99, 101).

(b) Teeth in which the side of the root has been perforated and infection of the lateral peridental membrane with bone destruction has occurred (Fig. 103).

(c) All upper molars and most lower teeth with extensive periapical granulomatous, suppurating or cystic areas, even without radiographic evidence of root roughening or absorption, and even comparatively small areas in which the x-ray reveals root roughening or absorption, because the locations of these teeth are as a rule not favorable for more conservative surgery (Fig. 104).

Fig. 105.—Molar roots communicating with maxillary sinus.

(d) Cases in which there is a sinus opening externally on the skin or into the antrum of Highmore or nasal fossa (Figs. 93, 105).

Cases falling in the above-mentioned classes should be placed in the group for extraction regardless of whether the patient is otherwise healthy or not.

(2) *Preliminary sterilization and filling of the root canal, followed by root resection and eradication of the diseased periapical area.*

This treatment applies to upper incisors, canines and premolars, and possibly lower incisors, with periapical granuloma, suppuration or cyst, with roughening or absorption of apical cementum not involving more than one-fourth of the root (Fig. 100). Teeth falling in this class should usually be extracted without attempts at conservative surgical treatment in cases in which they are believed to be the

cause of serious systemic infection. Teeth in which after root resection radiographic or clinical evidence three months later shows no reduction or obliteration of the periapical area, should also be extracted.

It is not possible at this time to give any definite figures as to the percentage of cases in which this operation is successful, nor are there any published statistics bearing on this point. In the Oral Surgery Clinic at the University of Pennsylvania about fifty root resections are performed during the year. In a clinic of this kind it is very difficult to follow up the cases. It would be of considerable value, however, to ascertain the late results in a large series of cases operated on with uniform technic. It is likely that this method of treatment may be tried in the conditions and on the teeth mentioned above, as an alternative to extraction, with chance of success in a majority of cases.

(3) *Preliminary sterilization and filling of the root canal, followed by surgical eradication or drainage of the diseased periapical area, the root apex being left intact.*

This treatment applies to cases in which there is no denudation or necrosis of the root apex, i. e., not sufficient to warrant root resection, yet periapical granuloma, suppuration or cyst exists. Cases in which there is no evidence of denudation or necrosis of the root apex, yet in which a chronic suppurative condition requires drainage should be treated by opening the periapical region through an incision in the gum rather than attempting drainage through a minute root canal. If the canal can be cleansed and maintained in a dry state sufficiently long to be filled properly, the filling may be done immediately, and further treatment of the suppurating area carried out through the opening in the gum and alveolar process. Prolonged root canal treatments in these cases are useless. It may sometimes be advisable to defer the root canal filling until after drainage through the opening in the gum.

In all cases of lesser periapical involvement, including small granulomas, where the patient is otherwise healthy, conservative root canal treatment may be attempted. There is good evidence, radiographic and clinical, that many of the cases of lesser periapical involvement clear up under modern methods of root canal treatment, by ionization, dichloramin-T, etc.

## CHAPTER XIV

# OPERATIONS FOR THE ERADICATION OF CHRONIC PERIAPICAL INFECTIONS

## EXTRACTION AND ERADICATION OF DISEASED PERIAPICAL TISSUE

At the present day, in the eradication of periapical infections, whether tooth extraction is part of the treatment or not, no operative work should be attempted without a preliminary radiographic examination. In these cases extraction is often only a part of the treatment, being that part which is concerned with removal of the original cause and in gaining better access to, and drainage of, the diseased bone area. To insure removal of the disease in the adjoining bone, extraction must be followed by curettement when the radiograph reveals the presence of a well-developed granuloma or cyst. It should be remembered that every granuloma is a potential cyst. We almost every day have evidence of the evil results of neglect of curetting after extraction because the extractor failed to be guided by x-ray evidence. It is true that often extraction alone will enable Nature to take care of the remaining periapical disease, but it is equally true that healing of a tooth socket may take place over a mass of granulation tissue or a cyst which will later give rise to serious trouble and require a second operation (Figs. 98, 102). The aim of many exodontists seems to be to extract the largest number of teeth in the shortest possible time, and they are forced into this by the usual method of anesthesia with nitrous oxide. Extraction specialists in the past have prided themselves on being able to "keep one in the air all the time." Finger agility is a very desirable gift in this work, but it is often employed to the detriment of the tissues. In the hurry incident to nitrous oxide anesthesia, teeth are often extracted with little regard for the adjoining soft tissues, the increased hemorrhage obscures the field, and there is no time to give minute attention to the diseased bone or to the proper care of the tissues in order to promote rapid and smooth healing after the extraction. These objections are all overcome by the use of novocain as a local anesthetic, which should be the anesthetic of choice in all operations for the relief of chronic periapical infections.

In curettement after extraction the operator should be guided by the extent of the disease process shown by the radiograph. The curetting need not and should not be too vigorous,—just sufficient to remove, or at least thoroughly loosen, the diseased soft tissue, without carrying infection into surrounding healthy bone. Curettes of all shapes and sizes have been designed for this work, but we have found that an adaptation of the ordinary chalazion curette, used by the oculist, to be most suitable (Fig. 24). Curettement is unnecessary in cases of suppuration where no granulation tissue is present, and indeed may do harm by spreading infection.

After extraction and curettement the local anesthesia permits such treatment of the alveolar process and gums whereby a smooth healing is promoted and much time is saved before the insertion of artificial dentures. This treatment consists in trimming and smoothing off the redundant alveolar process which would otherwise require weeks and months for absorption. This trimming is carried out by means of rougeur forceps (Fig. 24). The free gum margins are then trimmed and approximated here and there with horsehair sutures. These sutures are so placed that they will permit the escape of any secretion that may accumulate from the infected tooth sockets, and yet at the same time prevent an undue amount of bone from being exposed. As a general thing these wounds heal practically by first intention.

In many cases, such as those in which there is so much hypercementosis of the root or condensation of the alveolar process as to entail considerable injury to the bone in extraction by the usual method, a semilunar flap of buccal gum with convexity toward the neck of the tooth is raised, and the bone overlying the root removed by means of a chisel or bur, exposing the root to its apex. The root can then be easily removed through the lateral opening. This method also opens the diseased periapical area to direct inspection by the operator. After curettement the gum flap may be sutured back in place, drainage being secured if necessary through the tooth socket.

## ROOT RESECTION AND ERADICATION OF THE DISEASED PERIAPICAL AREA

There are few operations, even of major importance, that have so many names as the one under discussion, for example: apicoectomy, apiectomy, root amputation, etc. Of those in common use, the term resection, first suggested by Dr. Thomas L. Gilmer, is preferred, as it is simple, and seems to conform most closely to surgical nomenclature.

As stated before, the position of the tooth in the mouth is a factor of primary importance in considering the advisability of performing this operation in preference to extraction. Other things being equal the largest percentage of successful results will be in connection with upper incisors, canines, and premolars, as these are accessible and can be operated upon with the least risk of contamination from external sources. Lower teeth, with the possible exception of the incisors, are as a rule unfavorable subjects for resection (1) because of the thickness of the external bony plate, and (2) because of the almost inevitable contamination of the field of operation by the saliva. In upper incisors, canines and premolars, root resection for apical disease may be undertaken where not more than the apical fourth of the root is involved, where the tooth has not been loosened by the disease, and at the same time there is little or no destruction of peridental membrane or alveolar process from the gingival side.

**Preliminary Treatment.**—The root canal of the tooth should be sterilized and filled to as near the apex as possible before performing the operation. If the tooth is one already containing a root canal filling, even though this apparently reaches the apex, the canal should be re-treated and filled. It is better to insert the canal filling before the resection rather than afterward, because of the danger of reinfecting the apical region by reopening it through the root canal. The most suitable canal filling is oxychloride of zinc carried in on a gutta-percha point. This hardens in the canal and will not be disturbed when the root end is removed. Before the operation the x-ray films should be carefully studied, in order to gain an exact idea of the position and shape of the root, the proximity of the maxillary sinus or nasal fossa, the extent of the apical area of disease, and the length of the root filling.

*Importance of Asepsis.*—This operation should be performed with regard for modern principles of asepsis, and every effort made to exclude external bacterial contamination from the field of operation. Success can be best assured by observation of the same precautions in this regard as in any surgical operation. Since the fingers need not come in contact with the wound during root resection, the elaborate hand sterilization so essential in general surgical operations is as unnecessary as it is unpractical in working in the mouth, provided a technic be employed whereby no portion of the instruments or materials, that has been previously contaminated by handling or touching anything unsterile, touches the field of operation. By fol-

lowing out the principles of asepsis we run a minimum risk of failure and facilitate healing. We also are enabled, in cases where this is advisable, to obtain cultures from the infected tissues with little risk of contamination by extraneous bacteria.

The following instruments and materials are required:

Lip retractors (Fig. 22).
Scalpel.
Periosteal elevator or blunt dissector (Fig. 22).
Small curved scissors.
Straight dental chisel.
Hooked retractor with two or three prongs (Fig. 22).
Small cross-cut fissure bur, with slightly tapering sides.
Small grasping forceps (Fig. 23*c*).
Ordinary dental pliers (Fig. 23*b*).
Mouse-toothed tissue forceps (Fig. 23*a*).
Periapical curettes (Fig. 24*b*).
Small curved cutting edged needles.
Needle holder (hemostatic forceps) (Fig. 23*c*).
Horsehair.
Wood applicators mounted with cotton at each end.
Small gauze pads (2x2 in.).
Larger gauze pads (6x6 in.).
Towels.
Trays for instruments.
Tincture of iodine.
10% silver nitrate solution.
Syringe and solution for local anesthesia (Fig. 326).

The metal instruments, horsehair, and trays are sterilized by boiling. Before sterilizing, the needles are threaded with the horsehair and mounted in the needle holder. This avoids undue handling afterwards and saves time. The applicators, the gauze pads and the towels are wrapped up in packages and sterilized by steam. The end of the engine hand-piece is sterilized by dipping in alcohol and burning off in the flame.

The instrument table is covered with a sterile towel, the sterilized trays containing the sterilized instruments are placed upon this. The patient's head is covered with a sterile cap or towel, and a sterile towel is fastened around the neck. The lip is raised, the points of injection are painted with tincture of iodine and the novocain-adrenalin solution introduced. Either nerve-blocking or infiltration anesthesia may be employed or a combination of the two is sometimes preferable. After the parts have become anesthetized, a large pad of sterile gauze is placed between the teeth and the patient instructed to

bite on it. The teeth remain closed on this until the end of the operation. The lip is raised with a retractor and the gums and crowns of the teeth exposed are painted with tincture of iodine. Small gauze pads are placed under the lip on each side to exclude any saliva from the field of operation which escapes the gauze pad between the teeth. In the majority of cases the operative field can thus be rendered secure from external contamination until the incision has been closed.

**Operation.**—A curved incision, three-quarters to one inch in length is made in the gum over the root to be operated on with its

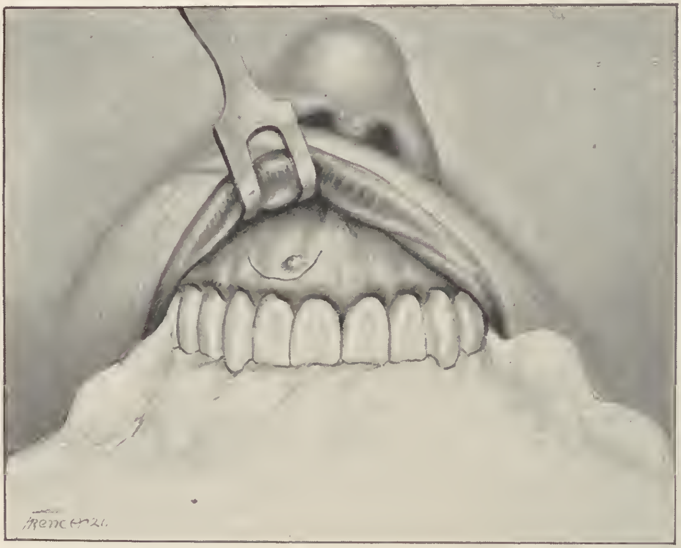


Fig. 106.—Root resection. Initial incision.

convexity toward the crown of the tooth, its lowest point approaching within a quarter of an inch of the gingival margin, the ends of the incision slightly overlying the roots of the adjacent teeth (Fig. 106). Sometimes in the case of a central incisor it is necessary to divide the frenum in order to obtain a good exposure. This does no harm and the divided frenum can be sutured back in place afterward. With the periosteal elevator, the mucoperiosteum is detached from the bone in the form of a flap, extending from the incision to a point above the apex of the root (Fig. 107). The bleeding is controlled by momentary pressure with a gauze pad. The flap is held up with a hooked retractor. With a small fissure bur an oval groove is made in the bone, the groove enclosing as much bone as it is considered

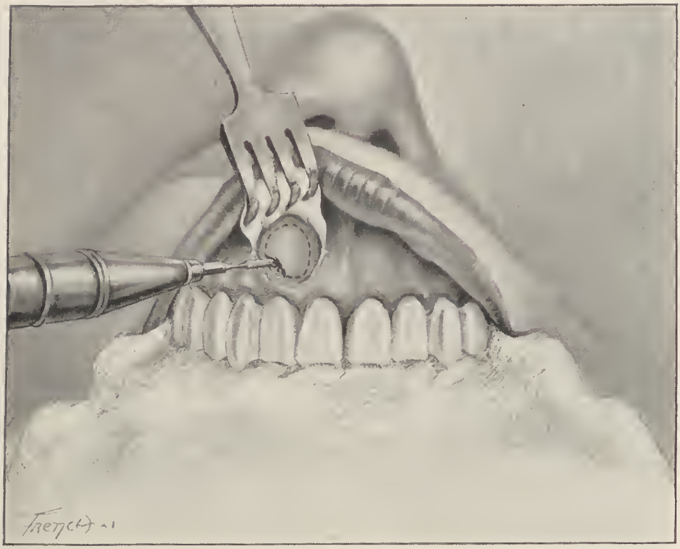


Fig. 107.—Root resection. Gum flap turned up, exposing outer bony plate.

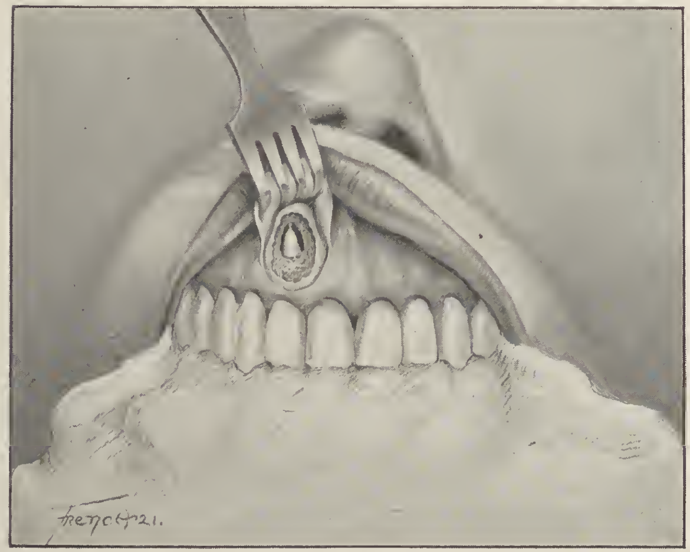


Fig. 108.—Root resection. Root apex exposed after making window in bone.

necessary to remove to obtain a good exposure of the root. The button of bone is then loosened with the chisel and picked out with the small grasping forceps. The root should now be exposed to view from the apex down to the point at which the resection is to be made, otherwise more bone should be removed with the bur (Fig. 108). With the same or a similar fissure bur, the root end is now removed, the bur being carried from one side to the other (Fig. 109). The final loosening may be made by inserting the chisel in the groove formed by the bur. The detached root end is grasped with small forceps and

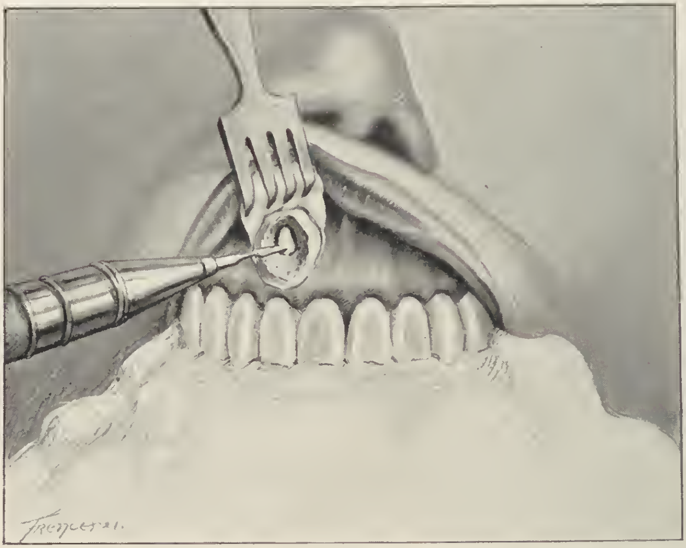


Fig. 109.—Root resection. Resection of apex with fissure bur.

removed (Fig. 110). It is examined to see that the root filling extends into the portion resected. A culture can be made at this point if desired. Any inflammatory tissue, cyst wall or other pathological material is now removed with the curette. In the presence of granuloma or cyst, it is of the utmost importance to remove mechanically all pathological tissue and not to stop until a wall of healthy bone is reached (Fig. 111). For wiping out the cavity, the wooden applicators are used. The root end is now smoothed over with the fissure bur, though the minute smoothing and polishing frequently advocated are not necessary. The x-ray shows that Nature will take care of any little roughness and sharp edges by absorption. It is important to do all that is possible to avoid reinfection of the apical area from the tooth.

With this end in view, some operators are in the habit of covering over the exposed root end with some foreign material, such as amalgam. The difficulty of sterilizing amalgam, in addition to its being a foreign body, would certainly seem to be a factor against the success of this practice. We believe the same purpose can be more effectively served by touching the root end with 10 per cent solution of silver nitrate. By this means we believe the open tubuli of the bare root end are sealed, and any bacteria in them prevented from emerging. Care should be used to confine the silver nitrate to the root end. In cases of granuloma or cyst formation when no free pus is present, the

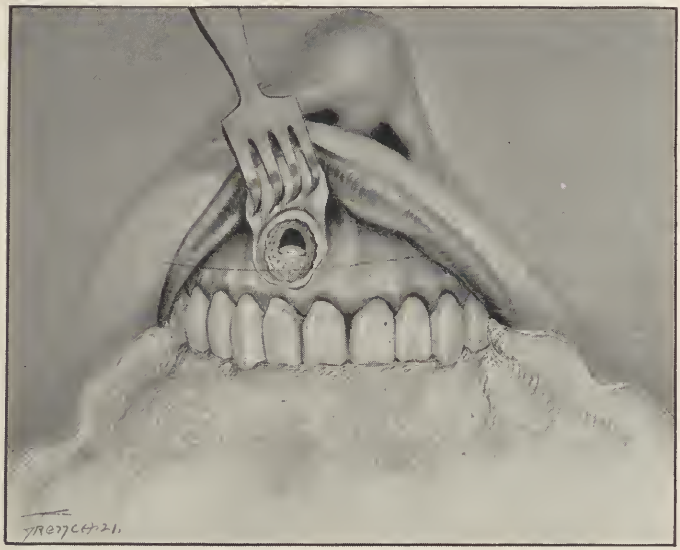


Fig. 110.—Root resection. Appearance after removal of apex.

wound may be treated by the closed method. By lightly curetting the walls of the bone cavity, this fills with sterile blood, which is allowed to remain. The hooked retractor is then removed, and the flap sutured in place with two or three horsehair sutures (Fig. 112). If the operation has been performed with strict observance of asepsis, and if the diseased tissue has been entirely removed, the blood clot under the flap remains sterile, undergoes organization, and finally bone is regenerated, encapsulating the root end. The incision under these conditions generally heals by first intention, and the sutures can be removed in four or five days. This compares very favorably with the slow healing and long and tedious after-treatment entailed

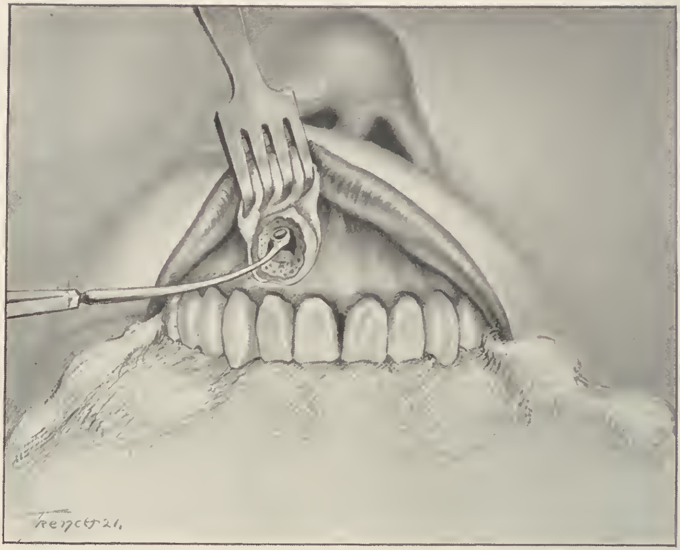


Fig. 111.—Root resection. Curettement of periapical area.

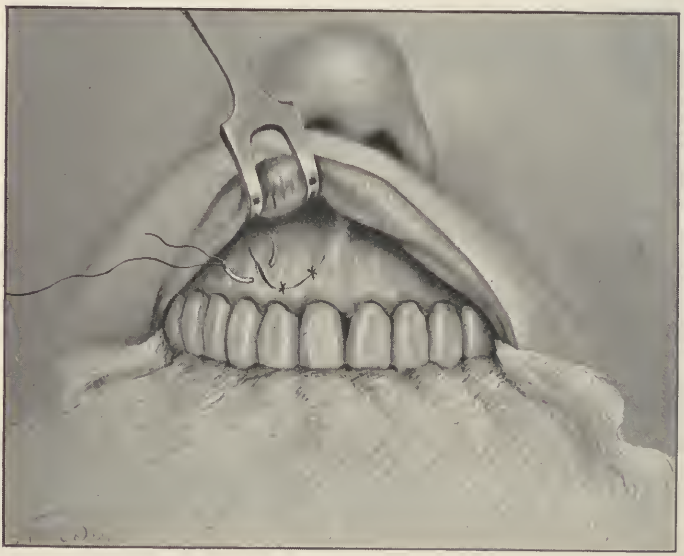
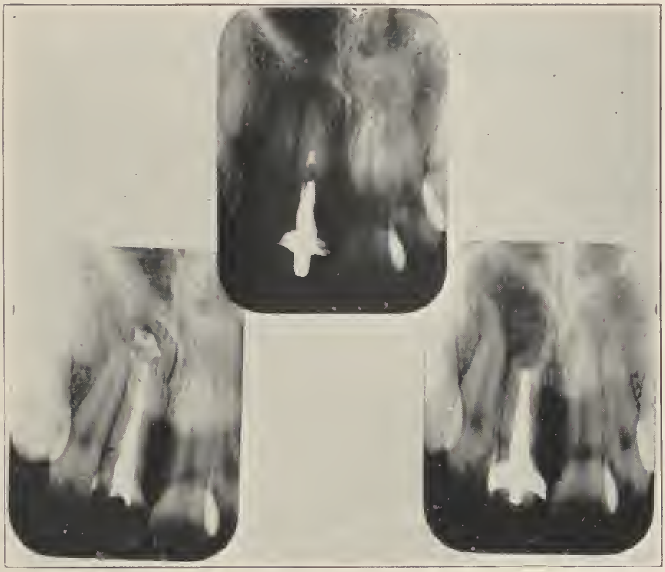


Fig. 112.—Root resection. Suture of flap.

by packing the cavity with gauze and allowing it to heal from the bottom by granulation. If symptoms of suppuration beneath the sutured flap appear, it is a simple matter to remove the sutures and pack the cavity. No time has been lost, no damage has been done, and the incision has been given the opportunity to heal by primary union, as it will in most cases. In cases in which suppuration is present at operation, the wound should not be sutured, but the cavity should be packed with a strip of iodoform gauze, which should be changed daily, until at the end of several days all suppuration having

*a*



*b* *c*

Fig. 113.—Upper central incisor showing granuloma (*a*) before treatment, (*b*) after root canal filling, and (*c*) immediately after root resection. (Ennis.)

ceased and the walls of the cavity being covered with healthy granulations, packing may be discontinued.

Cases in which root resection has been performed should be radiographed every three months to determine the progress of bone regeneration. If no progress is seen after three months, the tooth should be extracted (Fig. 113).

## Treatment of Cysts

The treatment of dental root cysts requires special consideration. The responsible tooth if present must be dealt with either by opening,

sterilization and filling of the root canal, root resection or extraction, according to location in the mouth, amount of destruction of peridental membrane, and other circumstances. The cyst itself may be treated by one of three methods, according to the indications:

(1) The smaller cysts, in which there is no visible swelling, or thinning of the surrounding bone, are treated by complete extirpation. After turning up a mucoperiosteal flap, the front wall of the cyst is removed and the entire cyst sac shelled out with a curette. The smooth-walled bony space is then allowed to fill with blood and

Fig. 114.—Dental root cyst connected with upper central and lateral incisors, curettement and packing indicated.

the flap is replaced and sutured. The blood clot filling the bone cavity will undergo organization, and will finally be converted into new bone. It is important that all of the epithelial lining of the cyst be removed, otherwise recurrence is likely to follow (Fig. 100).

(2) In larger cysts, and in the smaller ones where secondary suppuration has occurred, it is advisable after curetting to pack the bone cavity for a few days with iodoform gauze, rather than suture the flap (Fig. 114). The packing should be changed at least every forty-eight hours. As soon as the bone cavity is lined with healthy granulations, the packing may be discontinued and the cavity filled with bone wax, the formula of which follows:

| | |
|---|---|
| Olive oil | 8 parts |
| Yellow wax | 28 parts |
| Aristol or Iodoform | 4 parts |
| Paraffin wax | 4 to 8 parts |
| | (Prinz.) |

This is melted in a flask over a water-bath, the bone cavity is thoroughly dried, and the wax poured in and allowed to set. This keeps food and reinfection out of the wound, and is gradually extruded as the granulations fill up the cavity from the bottom. As a rule the wax does not have to be renewed oftener than once a month, and by avoiding the necessity of changing packing saves an enormous amount of time to the patient and the operator.

Fig. 115.—Partsch operation. Appearance before operation.

Large cysts may also be completely shelled out. This method is employed especially in the lower jaw. In the upper jaw, in shelling out large cysts, one can easily open into the nose or the maxillary sinus, and great difficulty may be experienced in getting this opening to close (Figs. 101, 102). For this reason, among others, an operation on an entirely different principle is recommended for these cases, viz., that designed by Partsch.

(3) *The Partsch operation* consists in removing the labial or buccal wall of the cyst, converting the cyst cavity into a shallow depression continuous with the oral cavity. Under local anesthesia, the lip is raised with a retractor, and a curved incision made in the mucous

membrane over the swelling, convexity downward (Fig. 115). The gum flap is separated from the underlying thin bone and turned up

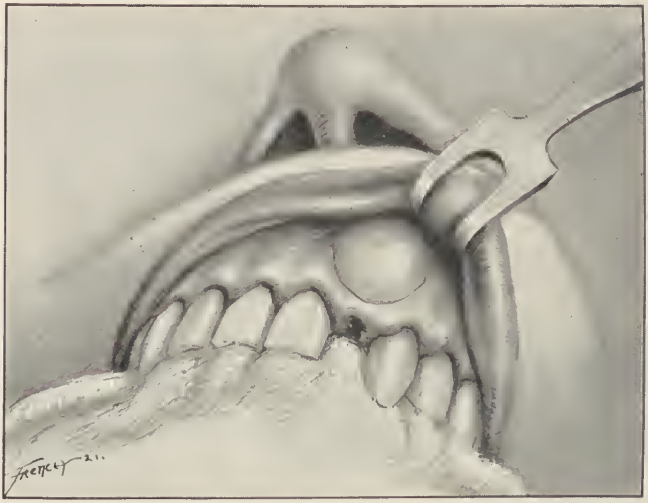


Fig. 116.—Partsch operation. Initial incision.

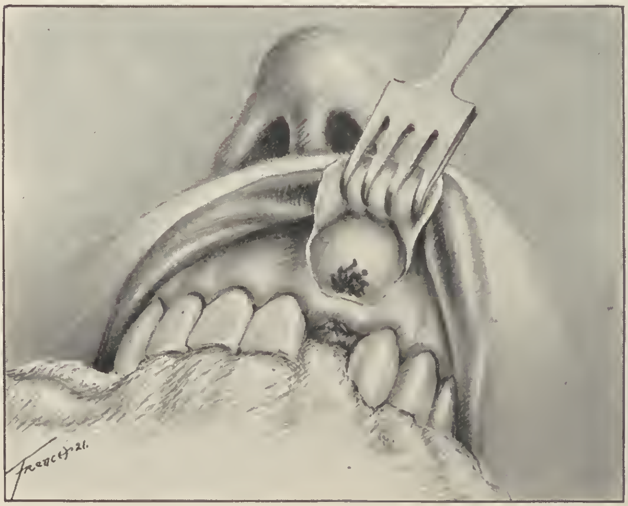


Fig. 117.—Partsch operation. Gum flap turned up, exposing bulging bony plate over cyst.

over the entire limits of the cyst, exposing its outer wall (Figs. 116 and 117). This thin cyst wall is now pierced with a knife, permitting the discharge of fluid (Figs. 118, 119). Then the entire anterior

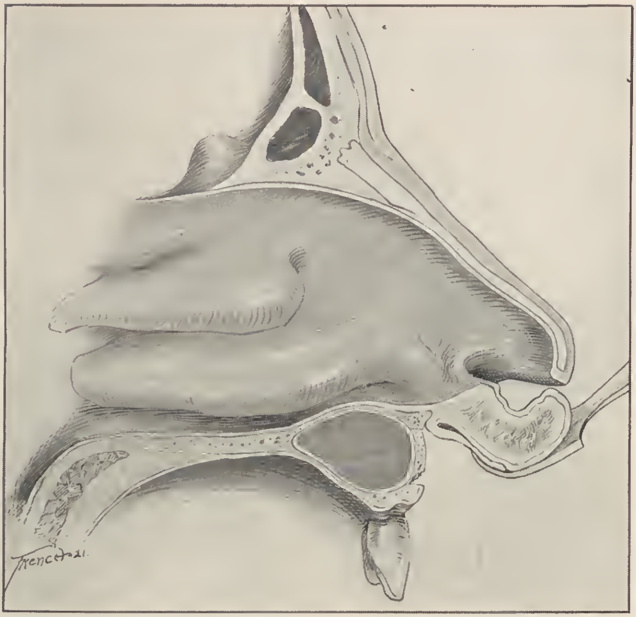



Fig. 118.—Partsch operation, sagittal section showing gum flap turned up.

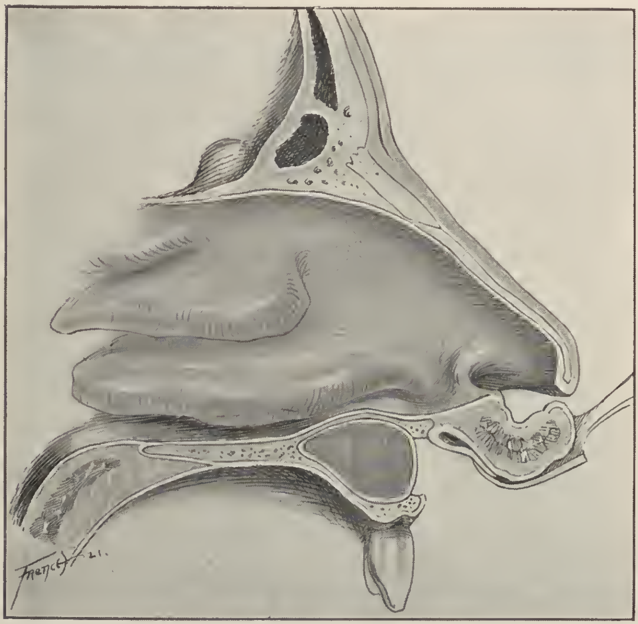



Fig. 119.—Partsch operation, sagittal section showing anterior bony wall of cyst removed.

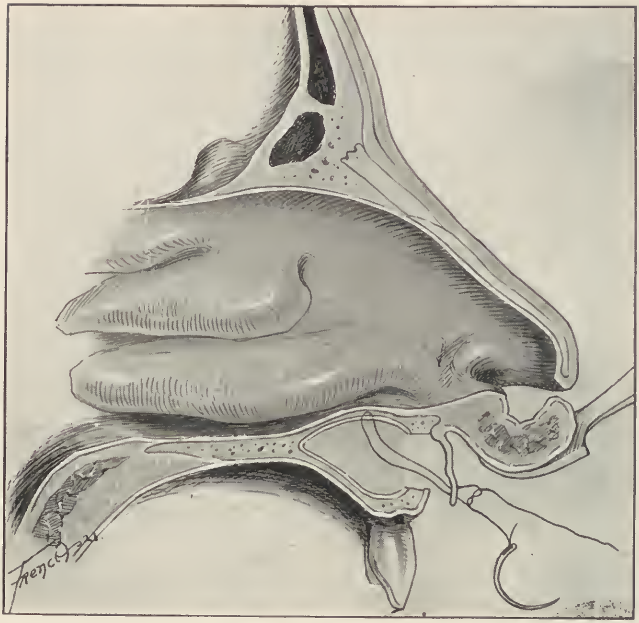


Fig. 120.—Partsch operation, sagittal section showing anterior membranous wall of cyst and gum flap sutured to upper wall of cyst.

Fig. 121.—Partsch operation, sagittal section showing cyst cavity packed.

bony and membranous wall of the cyst is removed in one piece with the knife, scissors or chisel, and trimmed away with rongeur forceps until no overhanging margins are left. The successful result of the operation is entirely dependent upon the wide opening. If the roots of adjacent teeth stand in the way of thorough removal of the overhanging margins, they must be resected or extracted. The remaining epithelial lining at the deeper aspect of the cyst cavity is not curetted away, but is allowed to remain *in situ*. Severe hemorrhage is seldom seen, and temporary packing will usually control bleeding. The raised gum flap is now turned in so that it covers the raw surface of the upper part of the cyst wall, and if necessary is sutured in this position (Fig. 120). After the operation the cyst cavity is packed with iodoform gauze (Fig. 121). All packing can be dispensed with in from seven to ten days. The healing of the wound will then have reached a stage where it can be left to itself. The patient should irrigate the cavity with warm salt solution by means of a soft rubber syringe (the ordinary ear and ulcer syringe obtainable at any drug store) (Fig. 25-*a*). There is usually very little reaction following the operation. The epithelium of the buccal mucosa becomes continuous with that of the posterior portion of the cyst wall, which assumes the characteristics of normal mucous membrane. The operation is followed by a slow decrease in size and depth of the bone cavity until all that remains is a shallow depression in the surface of the jaw.

## CHAPTER XV

# CHRONIC SUPPURATIVE PERICEMENTITIS

### (So-Called *Pyorrhea Alveolaris*)

The essential characteristic of this disease is a pus pocket along the side of the root of a tooth. It is always preceded by a gingivitis and there is a progressive destruction of the peridental membrane toward the apex of the root, with a tendency to spread very slowly around the root. Noyes* has recently shown that the principal route of travel of the infections beginning in the gingivae is by way of the perivascular lymphatics. As the blood vessels of the peridental membrane run for the most part parallel to the long axis of the tooth, this would explain the clinical observation that these pockets progress in depth more rapidly than laterally around the root. Gingivitis caused by deposits of serumal calculus and that caused by injuries are the most frequent forerunners. In a limited number of cases, constitutional causes may be responsible for the preceding gingivitis. It seems quite probable that several chronic systemic diseases may develop toxins which have an affinity for the gingivae, as has lead, bismuth, mercury, etc.

In any case, there is sufficient inflammation of the gingivae to permit a pyogenic infection and the deeper tissues become involved and destroyed. The peridental membrane is cut away from the surface of the root, the cementum being thus denuded. The principal fibers of the peridental membrane, which serve to attach the root to the bone, are destroyed, and later the portion of bone to which these fibers were attached disappears either by absorption or suppuration (Fig. 122). The cementum becomes saturated with pus and the products of the suppurative process. Deposits of serumal calculus may occur on the surface of the root and cause additional irritation. There is no more likelihood that these pockets will heal than there is of reattachment of the soft tissues to the root end in chronic alveolar abscess. The tendency is for more and more of the peridental membrane to be gradually destroyed. These cases tend to spread to neighboring teeth, not as much by direct involvement of the soft tissue as

---

*F. B. Noyes: Studies of the Pathology of the Peridental Membrane. Journal National Dental Assn., April, 1917, 375.

by causing slight movements of the teeth, thus permitting food to wedge between them and irritate the gingivae.

The tissue forming the pocket is a granulating connective tissue, the thin-walled blood vessels of which are easily penetrated by the organisms which may be growing within the pocket. This constitutes the systemic danger. Some years ago it was thought that this condition in the mouth was the result of gout, rheumatism, and other conditions. It seems now as though the reverse is true, that these systemic diseases often result from, instead of being the cause of, the mouth condition.

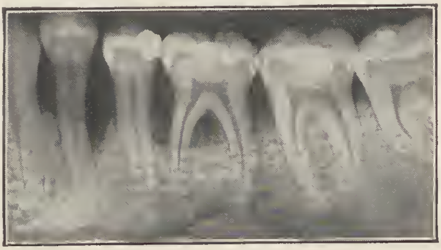


Fig. 122.—Reproduction of radiograph showing extensive destruction of the bone and alveolar process about lower bicuspid and molar teeth in a case of chronic suppurative pericementitis.—*G. V. Black.*

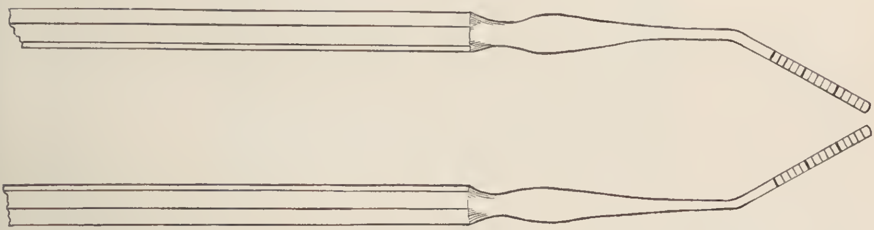


Fig. 123.—A pair of special explorers for measuring the depth of pus pockets. A millimeter scale is cut in the blades. It is not necessary to see the blade while in the pocket to make a sufficiently accurate reading; the serum within the pocket will adhere to the blade and the reading may be made after the instrument is removed.—*G. V. Black.*

Pus is formed within the pocket almost constantly in some cases, intermittently in others. Digital pressure will cause it to exude at the gum margin. The cervical lymphatics may be involved; there may be a slight rise of temperature. There is an excessive flow of saliva, often drooling during the night.

As a rule there is little or no complaint of pain in these cases. As the pockets get deeper, the teeth become loose and are likely to be tender to the stress of mastication. Occasionally the pus formed will penetrate the overlying tissue instead of being discharged along the

side of the root, and an abscess will result. This is called a *lateral alveolar abscess,* and should be distinguished from the true alveolar abscess occurring at the end of the root. These lateral abscesses are accompanied by the symptoms of an acute suppuration.

The extent of the detachments of the peridental membrane may be determined by using a thin flat blade with a smoothly rounded end (Fig. 123). Such an instrument may be passed alongside the root to the depth of the pocket. Radiographs will show the destruction of the bone of the alveolar process in all cases in which the depth of the pocket is below the level of the margin of the bone.

**Treatment.**—More teeth are lost today from the formation of pus pockets along the sides of the roots than from dental caries. This fact, together with the well recognized secondary systemic effects, and the intractability of these cases to treatment, makes it imperative that the best means of prevention be employed. Since a gingivitis always precedes the pericementitis, it is clear that more attention to the inflammation of the gingivae by both patient and dentist is greatly to be desired.

With the understanding that suppurative detachments of the peridental membrane from the cementum are permanent, we may lay down rather definite rules for treatment. We have a condition presenting a pocket along the side of a tooth's root, which makes a convenient incubator for the organisms of the mouth. Our first thought is that infection would not occur if the pocket could be kept clean. Two plans are proposed, either or both of which may be used in a given case. First the patient may be given a syringe of convenient form and taught to irrigate the pockets twice daily as a part of his mouth hygiene routine. Second, if the conditions in the particular case indicate that such a plan will not succeed, then the overlying detached soft tissue may be removed with the knife or cautery, after novocain has been injected (Figs. 124 and 125). Epithelium will quickly cover the raw surfaces. By this plan the pockets are at once eliminated, the granulating connective tissue is done away with, and the systemic danger is removed. As the detachment from the root is usually deeper than the destruction of the overlying bone, it is often necessary to trim off the edge of the bone, in order to remove the soft tissue to the full depth of the pocket. This operation may be for the elimination of a pocket on a single tooth, or it may consist of the removal of detached tissue about a considerable number of teeth (Fig. 126). The operation is not essentially different from that performed by Riggs fifty years ago. In some cases, the cutting away

Fig. 124.—Plaster model of case in which the tissue overlying a pocket on the buccal side of the mesial root of a lower first molar was cut away to reduce the depth of the pocket and facilitate the cleaning.—*G. V. Black.*

Fig. 125.—A case in which the distal root of a lower first molar was amputated on account of disease of the peridental membrane. The distal half of the crown of the tooth was also cut away, and a gold crown was made to restore the full occlusal surface.—*G. V. Black.*

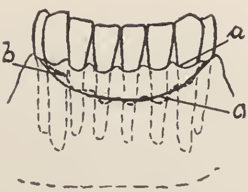


Fig. 126.—Sketch illustrating operation for elimination of pus pockets about a number of teeth, *a*, margin of inflamed gum tissue; *b*, depth of detachment of peridental membrane from root; *c*, line of incision to lay bare portion of roots. A similar incision is made on the lingual side and the septi of soft tissue between the teeth are also removed.

of the gum is contraindicated for cosmetic reasons. In all cases, it is important that the roots of the teeth be free from deposits.

Teeth which have lost so much of their membrane that they are loose should be extracted; or if the pockets are so deep that it is impractical to remove the overlying tissue, or to clean them effectually with the syringe, the teeth should be extracted. Their value for mastication must often be weighed against the systemic danger in their retention. Many patients have been observed, who, having pus pockets of varying depths about their teeth, have gone about their daily duties for many years, with sallow complexions, inactive physically, lacking initiative, never very sick but always deficient in vigor, and who have finally consented to the removal of the teeth with the surprising result that they have almost immediately come to take new interest in life, to be able to do more and to enjoy it, to have a better color, a sharper eye, and a quicker step, to have the feeling that they are really well and vigorous.

There is an impression made by these cases which convinces one that it is quite as important to keep mouths free from infection as other parts—that there is a wonderful field of preventive medicine open to the dentist.

# CHAPTER XVI

## INFLAMMATION OF THE MAXILLARY BONES

Inflammation of the jaw bones may be the result of infection involving either the periosteum (periostitis) or the marrow (osteomyelitis). In some cases the infection occurs simultaneously by both routes.

**Etiology.**—*General diseases,* such as syphilis, tuberculosis and acute exanthematous fevers (measles, scarlet fever, etc.), may interfere with the nourishment of the jawbones, giving opportunity for the entrance and growth of pyogenic microorganisms.

*Poisons,* such as mercury, arsenic, cocaine and phosphorus, cause periostitis and osteomyelitis either by their direct action or by so lowering the resistance of the tissues that pyogenic bacteria gain entrance. Mercury may cause osteomyelitis in those who work with the metal, or the disease may be a late stage of the stomatitis that follows overdosage of the drug. Arsenic and cocain may cause a direct poisoning of the tissues when applied locally as therapeutic agents. Phosphorus causes osteomyelitis of the jaws in workers in the manufacture of matches who pay little or no attention to hygiene of the mouth. The phosphorus in solid form or by its fumes probably gains entrance to the jawbone through devitalized pulps of carious teeth, or through an inflamed peridental membrane. The white or yellow phosphorus is the poisonous form. The red, amorphous variety is nonpoisonous. Since the passage of prohibitive legislation against the use of white phosphorus in match manufacture necrosis from this source has been practically eliminated.

*Local infections* following alveolar abscess, stomatitis, or severe injury to the jaw such as fracture, may set up periostitis or osteomyelitis. The use of hydrogen dioxid about an infected area communicating with the bone is a common cause of osteomyelitis. When this drug comes in contact with organic material free oxygen is given off, and in an enclosed space, such as an alveolar abscess with a small opening, it tends to drive the infected material before it through the cancellated bone tissue. The hypodermic injection of novocain or any drug into inflamed tissues to produce local anesthesia for the extraction of a tooth may act in a similar manner by carrying

infection from around the tooth into the surrounding tissues and thence to the bone. Osteomyelitis or periostitis may thus occur quite independently of any toxic action of the drug itself.

Periostitis or osteomyelitis from any of the foregoing causes may end in *caries* or molecular destruction of the bone, or may result in *necrosis* or death of a portion of the bone *en masse*. Necrosis may also result apart from infection, from a sudden cutting off of the vascular supply to the bone by traumatism, although in the jawbones this is nearly always complicated by a secondary infection from the microorganisms of the mouth. In the lower jaw particularly, not so frequently in the upper jaw, the destructive process resulting in caries or necrosis is nearly always accompanied by the formation of a shell of new bone surrounding the inflammatory focus.

**Symptoms.**—In periostitis and osteomyelitis the usual signs of inflammation are present. There are deep-seated pain and tenderness over the bone affected, which do not disappear with the usual treatment of a simple alveolar abscess. The affected side of the face becomes greatly swollen and in the case of periostitis of the lower jaw, there is difficulty in opening the mouth because of involvement of the insertion of the muscles of mastication. General symptoms—fever and prostration—are usually greater than those caused by an ordinary alveolar abscess. Grave septicemia and even pyemia, with metastatic abscesses of other parts of the body, may result. The pus eventually makes its way to the surface of the bone, and is evacuated in the mouth or points on the face or neck, leaving sinuses. When necrosis occurs, the dead bone can be felt by passing a probe up the sinus. The mouth of the sinus generally has projecting from it a mass of granulation tissue. Osteomyelitis is much more frequently followed by necrosis than periostitis. In the latter it frequently occurs that the outer surface of the bone becomes denuded of periosteum, yet the exposed bone becomes covered with new tissue without sequestrum formation. In the early stages of necrosis the sequestrum is not separated from the rest of the bone, but later becomes quite loose and may be thrown off spontaneously. A large area of dead bone may become entirely uncovered by the soft tissues, and may easily be seen. The different causes of necrosis may give rise to variations in the character of the sequestrum. In syphilis, the dead bone is usually black and soft. In phosphorus poisoning it is white, hard and brittle, giving rise to the term "pumice-stone" necrosis. There is usually a strong odor of phosphorus in these cases.

The necrosis may be slight in extent, or it may involve the whole

Fig. 127.—Extensive osteomyelitis of mandible.

Fig. 128.—Sequestrum at lower border of mandible, following suppurative periostitis.

bone. In the mandible, an entire shell of new bone may be formed about the sequestrum. In the earlier stages of osteomyelitis the x-ray findings may be negative, before marked changes in density have had time to occur. Later, radiographic examination becomes a valuable aid in determining the condition of the bone, whether the process is one of caries, or whether sequestrum formation is taking place (Figs. 127, 128).

**Treatment.**—It is of the utmost importance that conditions either general or local which are likely to develop into bone inflammation receive early attention. In all operations involving the alveolar proc-


Fig. 129.—Loss of substance of mandible with pseudoarthrosis, due to lack of regeneration following early removal of sequestrum.

esses and infections of the mouth there should be the strictest attention to surgical principles and adequate provision of drainage.

If periostitis or osteomyelitis has begun, any cause that may be manifest, such as an abscessed tooth, should be removed. As a palliative measure, an ice bag applied to the side of the face will often relieve the pain, although sedatives will generally have to be administered. When there are indications that pus is present, it should be evacuated, through the mouth if possible, and if not, through as small an external opening as is necessary to give drainage. In acute cases of osteomyelitis seen before the pus has perforated the outer plate of

the bone, it may be necessary to make an opening through this outer plate with a drill or chisel in order to provide for the escape of the pus.

When dead bone is felt, one must be guided by the indications of the individual case and by experience whether to remove it or wait until separation of the sequestrum occurs. It is better to remove small portions from time to time than to do a radical operation too early. In this way the osteogenic cells are more likely to be preserved for the formation of new bone, and less disfigurement results. If new bone be allowed to form coincidentally with destruction of the old bone, the continuity of the jaw is preserved, and pathologic separation or fracture through the diseased area is not so liable to occur (Fig. 129). Some cases, however, on account of the effects on the general health, demand early and thorough eradication of the necrotic area. A cardinal rule is to remove sequestra from within the mouth when possible, thereby avoiding scars on the face or neck. Loose sequestra should of course be removed at once. If the sequestrum does not loosen within six weeks after the presence of dead bone is definitely ascertained, it is proper to perform an exploratory operation. An adequate incision should be made in order to expose the seat of necrosis to the eye, so that all of the dead bone may be removed, the walls of the bone cavity be made smooth and no pockets be left. By trimming off overhanging margins of the bone cavity, collapse of the soft tissues will frequently occur, resulting in much quicker healing than if a large bone cavity be left surrounded by rigid bony walls. When a loose sequestrum has been taken out, the walls of the cavity will be covered with granulations having a smooth and velvety feeling to the finger. After the operation the opening may be lightly packed with a strip of gauze to control oozing. Sinuses on the face or neck will close almost immediately if all of the dead bone has been removed and if the walls of the cavity can collapse. In some carious conditions, where after curettement a large noncollapsible bony cavity remains, after the walls have been covered with new granulations, the use of bone wax, as described in Chapter XIV, is very efficacious.

The general condition of the patient in osteomyelitis and necrosis of the jaws requires careful attention. If there is much fever the patient should be kept in bed, on liquid diet, and stimulation given if required. Later the patient should be built up by nourishing food, tonics, fresh air and sunlight.

## CHAPTER XVII

## EXTRACTION OF TEETH

The primary causes which lead to the extraction of teeth may be summed up as follows:

1. The ravages of dental caries that are beyond repair.

2. Diseases of the alveolar process: viz., tumors, pyorrhea alveolaris, alveolar abscess, etc.

3. Irregular position of the teeth. This will include cases which require removal of the teeth preparatory to correction of deformity of the jawbone.

4. Impaction of the teeth.

5. Accidents to the teeth or their surrounding structures.

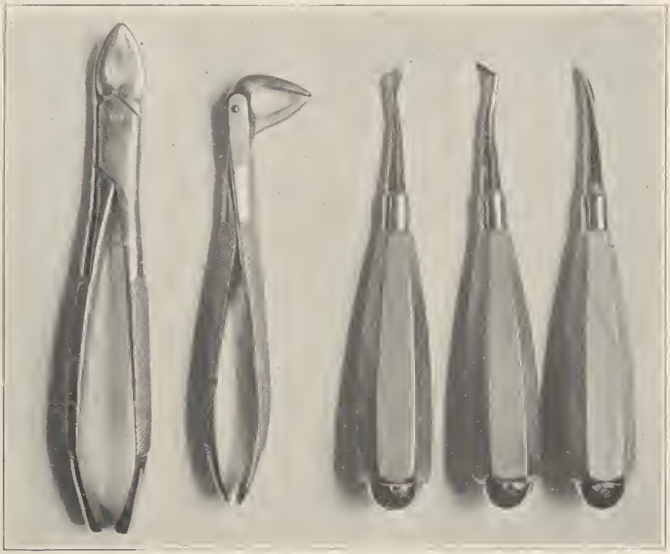
These various indications hold good for permanent as well as for temporary teeth. The extraction of temporary teeth is indicated when they are so affected with disease that they cannot be restored artificially; a simple inflammation of the pulp should never be the reason for its extraction. The irrational extraction of temporary teeth frequently causes irregularities of the coming-in permanent set, which cannot be corrected by future treatment.

Before undertaking the extraction, the field should be cleaned, and adhering deposits are to be removed. The painting of the soft structures within the immediate neighborhood with diluted tincture of iodin is to be recommended. This is composed of tincture of iodin, 1 part; ether, 1 part. This combination contains $3\frac{1}{2}$ per cent iodin and is especially recommended for surface sterilization of the tissues of the oral cavity. It will not burn the gum and dries almost instantaneously. Before applying the extracting instrument, the soft tissues should be thoroughly detached from the necks of the teeth to be removed, so that they will not be lacerated by being grasped with the forceps. This may be accomplished by means of a small tissue elevator (Fig. 22-*d*).

The special instruments employed for the extraction of teeth and roots are forceps and elevators. In special cases, where bone has to be removed, other instruments are required, such as chisels and mallet, burs, etc. A very large variety of forceps and elevators have been

devised. A few well-selected instruments will suffice for all but very extraordinary cases.

**Forceps.**—For a number of years we have found it unnecessary to employ more than two dental forceps, one for all upper teeth and roots and the other for all lower teeth and roots. For the extraction of all upper teeth and roots we use the Cryer universal upper forceps No. 150, and for all lower teeth and roots, the English "hawk-bill" pattern No. 74 root forceps (Fig. 130). Working on the theory that in extraction, it is the root of the tooth which must be removed from the socket, regardless of whether the root is surmounted by a crown



*a* *b* *c* *d* *e*

Fig. 130.—(*a*) Cryer universal upper forceps; (*b*) Hawk-bill universal lower forceps; (*c, d*) Cryer right and left elevators; (*e*) elevator useful in removal of impacted lower third molars.

or not, we have found that these two forceps are well adapted to grasp the root of any tooth, whether it be single or multirooted.

**Elevators.**—In addition to the forceps, a few elevators for the extraction of upper and lower stumps or misplaced teeth are very serviceable. Here again, we limit ourselves to two or at most three patterns. The Cryer right and left elevators (Fig. 130) are useful for loosening small roots which cannot be grasped with the forceps. For turning out lower third molars, especially when impacted, the Lecluse elevator, is a valuable instrument.

Regarding the position of the patient, it is well to bear in mind

that the light on the field of operation must not be obstructed; consequently, the patient should face the source of light. For the removal of the upper teeth, the patient is seated on a high chair, head leaning slightly backward; while for operations about the lower teeth, a low chair is to be preferred. The operator usually stands on the right side of the patient, the right hand firmly grasping the forceps, while the left hand is employed to draw the soft tissues well out of the way.

When under ether, the extractions are made in the recumbent position.

In applying the forceps to any tooth, one beak is first placed on the palatal (or lingual) side. The tooth is then grasped by slightly closing the handles of the forceps, and the instrument is pushed up (or down) as far as possible under the gum. The sharp edges of the beaks may be pushed even slightly under a weak alveolar process, and a firm grasp of the root is thereby readily obtained. This is especially important in the extraction of teeth whose crowns have been weakened by decay. Care should be exercised not to grasp the alveolar process with the forceps, as damage to the bone is a frequent cause of after-pain and delay in healing. If the forceps grasp the crown, it is very apt to be crushed, and the extraction of the root is made difficult; but if the crown, be it ever so delicate, is used as a guide for placing the edges of the beak well down on the neck or upper part of the root, success in extracting the root is more likely to follow. An effort is now made to slightly rotate the tooth, or slight lateral motion is applied, according to the shape of the root and the number of roots. Rotation of single conical rooted teeth is usually successfully accomplished, while those whose roots are not conical and multirooted teeth require a definite lateral motion, usually first inward, which is followed by an outward movement. Care should be exercised in not applying too much force laterally, as the tooth may readily break. The object of this lateral motion is to dilate the socket of the tooth by springing the outer and inner alveolar plates, loosening the root, which can then be lifted out without force. The extraction of teeth is not a matter of applying crude force; delicate movements of the whole hand governed entirely by the wrist are the essential features of this operation.

## REMOVAL OF THE INDIVIDUAL TEETH

The removal of the temporary teeth is usually accomplished without much difficulty. Children require careful handling; kindness and persuasion will do more with an unruly child than roughness and

display of temper. The universal forceps or an elevator may be employed for the extraction of temporary teeth.

The upper first premolar breaks frequently during extraction, on account of the often thin, flat roots. The canine is the strongest single-rooted tooth in the mouth, and frequently great force is required in loosening it. In the extraction of the upper first and second molars slight palatine and buccal motion is essential for their luxation; the final removal should take place in a downward and outward line. In using the universal upper forceps for removal of these teeth, the inner beak of the forceps is applied to the palatal root and the outer beak to one of the buccal roots, whichever gives the more secure hold, and not between the buccal roots. The upper third molars, if not misplaced, are usually very easy to extract, usually by an outward motion, the handle of the forceps being rotated outward, upward and backward toward the ear. Occasionally, an elevator may be employed to advantage in the removal of this tooth, but care must be used not to fracture the maxillary tuberosity lying behind the tooth.

In extracting upper premolar and molar teeth, special care is often necessary to prevent the pushing of a root up into the maxillary sinus. A radiograph will usually show the proximity of a root to the sinus.

For all lower teeth, the "hawk-bill" root forceps are empoyed (Fig. 130-*b*). As a guide and support to the forceps, the alveolar process adjacent to the tooth to be removed is grasped between the thumb and index finger of the left hand. The advantage of these forceps over the ordinary pattern is that the operator's wrist and hand do not interfere with a view of the beaks of the forceps, which can be seen throughout the operation. For the extraction of lower premolars and molars on the right side, the operator stands behind and to the right of the patient, while for the remaining teeth he should stand in front and slightly to the right. The lower incisors and canines are readily removed by firmly grasping them and tilting them labially; the thin alveolar process on the labial side will yield to pressure, and the teeth can be taken out without much force. The lower premolars are removed by a slight inward and outward movement. The lower molars having two roots, the beaks of the forceps are applied to either the anterior or the posterior root, and not between the roots. The third molar, when normally erupted, is usually easily extracted, the roots being often fused and curved backward. Occasionally, an elevator is of advantage in extracting the third molar, but care must be exercised in using the second molar as a fulcrum, as great damage may be done to the latter if great force is used. In using the Cryer ele-

vator for removal of broken-down roots, the point is engaged against the root, and the adjoining tooth or root used as a fulcrum by applying the smooth curved heel of the elevator against it. If roots are firmly embedded and can be grasped with the forceps, the latter should be employed. If a multi-rooted tooth fractures at the neck in the process of extraction, it is often best to separate the roots by means of a fissure bur in the dental engine and then dislodge them one by one with the forceps or an elevator. This procedure is preferable to trying to extract all of the roots with the forceps at once, which usually results in crushing them and inflicting great damage to the alveolar process. Novitzky, Gardner, and others advocate the removal of all teeth, not with forceps in the usual manner, but by exposing the root up to the apex through a gum flap and chiselling away the outer alveolar plate, and then picking out the root with an elevator. We believe the older method is more suitable for the majority of teeth, but the dissection method has its advantage in certain cases. For example, in cases where the alveolar process has lost its elasticity, and has undergone condensation from chronic infection, it may be very difficult to dilate the tooth socket by grasping the tooth with forceps. Where the radiogram and clinical signs point to an extensive periapical area of disease requiring surgical attention after removal of the root, much better access for curettement may be obtained by chiselling away the outer process through an opening in the gum. The newer method is also preferred where a portion of root has been left deeply embedded in the alveolar process, and cannot be readily grasped by the forceps or turned out by an elevator, or where there is extensive hypercementosis of the root. The technic consists in making a semilunar incision in the gum over the root with its lowest portion at the gingival margin, raising a flap with a small tissue elevator exposing the bone, and chiselling or burring away a window in the outer alveolar plate, exposing the root throughout its length. The root can then be dislodged by means of the forceps or an elevator. After curettement of the diseased bone condition, the gum flap may be replaced and sutured with catgut, horsehair, or Dermal suture, if desired, and drainage established through the socket.

**Care of the Tissues after Extraction.**—Extraction of teeth as ordinarily performed, and particularly when nitrous oxide is used as an anesthetic, is generally followed by little care of the gum tissue and alveolar process. It is surprising that healing proceeds as well as it does under these conditions. When several adjoining teeth have

been extracted, it frequently happens that there is considerable laceration of the gum, and sharp redundant edges of alveolar process are allowed to remain, which cause considerable discomfort to the patient and delay in the insertion of artificial substitutes while absorption is going on. It is therefore advisable after the extraction, to note the condition of the gum and alveolar process. If sharp edges of process are present, they should be trimmed off smoothly with rongeur forceps, after which the uneven gum edges can be cut to a straight line with scissors and brought together over the smooth bone with a few sutures. The sutures need not be so closely placed as to prevent drainage, in case infection be present. By attention of this kind, the gums will heal quickly and smoothly, and will be ready much sooner for an artificial denture.

The careful extraction of teeth and the other procedures often incident thereto can be performed much more readily under local anesthesia with novocain than under nitrous oxide, and the former is therefore the anesthetic of choice except under certain conditions, such as acute infection, which will be noted more in detail in the chapter on anesthesia (page 479).

Complications of extraction of teeth, such as hemorrhage, fracture of alveolar process, infection, etc., are dealt with in other chapters.

In the foregoing, the authors have limited themselves to a brief consideration of the salient principles of tooth extraction. For more detailed information, the student should consult works on exodontia.

## IMPACTED TEETH

A tooth is spoken of as being impacted when its eruption is partially or wholly obstructed by bone or some other teeth.

**Order of Impaction.**—The tooth most frequently impacted is the mandibular third molar. This is closely followed by the maxillary canine and third molar. Other teeth are occasionally impacted, but not so frequently as those mentioned. This is easily explained. The third molar, being the last of the posterior teeth to erupt normally, any condition tending to lessen the space provided for the molar teeth will naturally leave this tooth with insufficient room. The canine, being the last of the anterior teeth to erupt, suffers similarly from lack of space when this part of the jaw is affected.

Impacted teeth are found in various positions, shapes, and degrees of impaction. Sometimes they are partly erupted and can be seen, but often they are covered by the gum and by the bone. An impacted

lower third molar usually lies more or less horizontally, pressing at various angles against the second molar (Fig. 131). This tooth may be impacted without pressing against the second molar, and may be rotated in various directions, pointing backward toward the ramus, or it may be completely inverted.

Fig. 131.—Horizontal impaction of lower third molar.

Fig. 132.—Impacted upper third molar.

The upper third molar is usually impacted with its crown pressing against the second molar (Fig. 132), but the crown may be directed backward.

An impacted canine tooth is usually prevented from eruption by the roots of adjacent incisors or premolars, against which it presses. It may lie on the labial or the palatal aspect of the other teeth (Fig. 133).

The roots of impacted and misplaced teeth are often built into abnormal shapes during their development in order to avoid encroachment upon important structures, such as the maxillary sinus, the inferior dental nerve, etc.

Fig. 133.—Impacted upper canine teeth.

Fig. 134.—Impacted supernumerary lower premolar.

Impacted teeth may remain dormant in the jaws until long after the loss of adjacent teeth, and late in life start to erupt or give rise to inflammatory trouble due to absorption of the overlying bone.

In such cases infection may occur in the surrounding bone due to a minute communication with the mouth cavity, resulting in a focus of suppuration about the crown of the tooth. There may be a deposit of salivary calculus on the crown of the tooth.

**Etiology.**—Many pathologic conditions bring about retarded eruption, displacement and impaction of teeth. The growth of the jaws and the movement of the teeth are in a forward direction; consequently, anything which interferes with this forward movement or growth will cause impaction of the teeth. Acute infectious fevers of childhood, such as scarlet fever and measles, may interfere with the forward movement by producing a deposit of dense bone. Local increase in the density of the bone may also be brought about by inflammation of the peridental membrane extending into the alveolar process. The cancellated tissue, instead of being spongy and elastic, becomes hard and solid. This condition following caries of the first permanent molar soon after its eruption is a frequent cause of impaction of the third molar, especially if the first molar is treated and retained in the jaw. Early extraction of the first molar, so frequent in persons whose teeth receive little attention early in life, is rarely followed by third molar impaction.

The effects of contracted arches of constant mouth-breathers on the eruption and position of the teeth are well known. Severe traumatism to the jaws may cause a deposit of lime salts in the cancellated tissue and thus bring about impaction. Ankylosis of the mandibular joint in childhood, resulting in arrest of growth of the jaws, may leave insufficient space for the eruption of all of the teeth. Too early extraction of deciduous teeth may cause arrested development of the jaws and malposition of the permanent teeth, this leading in turn to impaction of unerupted teeth. In addition to injury, disease, and lack of development, it is conceivable that impacted teeth may result from hereditary causes, such as transmission of small jaws from one parent, and large teeth from the other. Irregularities are artificially produced in certain animals by breeders, and the same thing occurs in the human race accidentally.

**Symptoms and Diagnosis.**—Impacted teeth may be present without giving rise to any symptoms whatever. Others cause pain, which may be local in character, or neuralgic, distributed along the branches of the trifacial nerve. Sometimes, especially in the case of the lower third molar, cellulitis is set up, often accompanied by trismus. In any patient suffering from acute cellulitis in the back part of the mouth and inability to open the jaws, an impacted lower third molar

should be suspected. If the tooth is partially erupted, the diagnosis is at once apparent on inspection, but in other cases the diagnosis depends on absence of the tooth from the denture and the x-ray findings. Absence of a canine tooth from the denture, with no history of extraction, nearly always means that it lies impacted. Sometimes its presence is evidenced by a swelling in the hard palate or on the labial aspect. On the other hand, absence of a lateral incisor from the denture usually means that this tooth has never been developed. In elderly edentulous or almost edentulous persons, the first evidence of an unerupted tooth, usually a third molar or canine, may be the development of a lump under an artificial denture, or a focus of suppuration in the region of the impacted tooth. The x-ray is most valuable not only in detecting the presence of impacted and unerupted teeth, but also in accurately localizing them and determining the shape and position of the crown and roots, and the relation to adjoining teeth (Fig. 133).

**Disturbances Caused by Impacted Teeth.**—*Local Effects.*—An impacted third molar may press against the crown of the second molar and cause decay of that tooth, or itself become the seat of caries around the point of contact. It may also cause pressure absorption of the root of the second molar. Exposure and devitalization of the pulp from these causes may give rise to neuralgia. Neuralgia may be caused in another way by pressure of the roots of the impacted tooth on the inferior dental nerve or its branches. The irritation set up by an impacted tooth may cause condensation of the surrounding bone, with pressure on the nerve or its branches.

*General Effects.*—Various forms of reflex nervous disturbance may result from impacted teeth. Pain resembling that of true neuralgia may be referred to any of the branches of the trifacial nerve. Impacted teeth may be the cause of obscure headaches. Cases of more serious nervous or even mental disturbance have been at times traced to this cause. In such conditions as epilepsy, chorea, and dementia precox, impacted teeth may at least be a contributing factor. In these cases there may be no local signs of trouble.

**Treatment.**—An impacted tooth should not be removed without some special indication. In some cases, such as neuralgia or an infection around the unerupted tooth, the indications for removing an impacted tooth are very evident. In other cases, impacted teeth are removed on account of some symptoms present that might or might not be dependent upon the impaction, such as headache, nervous or mental disturbances.

If treatment is indicated, it consists as a general rule in removal, by operation, of the impacted tooth. In the case of impaction of the lower third molar, under eertain conditions, such as extensive disease of the seeond molar, it may be advisable to remove the second molar. In sueh eases the third molar may move up into the position of the tooth that has been removed. An impaeted anterior tooth, such as a canine, may in some cases be brought down into place by orthodontie treatment. If covered by a thick layer of bone, the erown of the tooth may be exposed by removal of the bone, and a traetion pin inserted into the tooth.

Removal of an impaeted lower third molar sometimes means a formidable operation. Both the erown and the roots of the tooth may be covered by a thick plate of bone, and the roots may be curved or separated in sueh a manner as to make removal very difficult. No set rules ean be formulated for all cases, but the general prineiple to be followed in operating is to first remove sufficient obstructing bone so that the tooth ean be lifted out with little foree. Usually an incision is made in the gum directly over the impacted tooth from behind forward and then continuing this at its anterior end downward on the buecal aspeet. This incision permits the turning downward and baekward of a muco-periosteal flap exposing the plate of bone over the tooth and on the buccal side. The bone covering the crown and roots of the tooth is now removed with a chisel or a bur as far back as is neeessary to give suffieient spaee to permit the crown of the tooth to be disengaged from behind the second molar. The tooth is usually removed by rotating the crown upward and backward by means of an elevator placed underneath it, the underlying alveolar process and not the seeond molar being used as a fulerum. It may be neeessary to remove a eonsiderable portion of the outer bony plate to permit the insertion of the elevator. Loeal anesthesia is preferred in these cases when possible. If acute infection and trismus exist, ether is the anesthetic to be ehosen. In simple cases, where only a little bone has been removed, after extraction of the tooth, the gum flap may be sutured back in place and the wound allowed to heal by organization of the blood elot. In more severe cases, where there has been much trauma, where eonsiderable infeetion is present, or where hemorrhage is expected, a light packing of iodoform gauze is inserted, and the wound left open or only partially elosed by sutures. The packing must be changed at least every forty-eight hours for several days, until new granulations have formed, when treatment by irrigation will be suffieient.

# CHAPTER XVIII

# SEPTIC INFECTIONS OF THE FLOOR OF THE MOUTH AND NECK

Septic infections of the neck are usually secondary to some infection in the mouth, nose, or pharynx, and in many of them the teeth are the portals of entry. From the mouth the infection travels into the neck by one of two routes: (1) by extension along the cellular tissue planes, or (2) through the lymphatics. In many, if not most instances, the infection travels by a combined route, but usually either the lymph nodes or the tissue planes show the greater involvement, and the resulting inflammation is designated accordingly as lypmhadenitis or cellulitis.

## ACUTE LYMPHADENITIS

This may vary from the enlargement of one or several nodes, which may quickly disappear with the subsidence of the primary focus, to the rapid swelling of a number of nodes in one or several groups, accompanied by pain, fever, suppuration, and diffuse periadenitis. Naturally, one of the upper groups of nodes is most commonly affected. The inflammatory process may remain limited to the neighborhood of the involved nodes, or may be widespread. When a gland capsule ruptures, the pus is liberated between the cellular planes, but it may still remain localized, held in place by a wall of granulations. In a very acute infection, the pus may form more rapidly than it can be walled off, in which case it will travel along the tissue planes under the deep cervical fascia and may enter the mediastinum or the axilla. A localized abscess may, if neglected, rupture spontaneously through the skin or travel along the tissue spaces and cause death before the pus can reach the surface. For this reason, the early drainage of suppurative adenitis in the neck is very important. Owing to the number of protecting lymph nodes in the neck, general infection through the lymphatics is not common. After proper drainage, if not too long delayed, recovery usually takes place. In the non-suppurative forms resolution may be long delayed, and a chronic hyperplasia of the nodes may result.

## ACUTE CELLULITIS

The most common instance of this is the swelling of the cheek or floor of the mouth which usually accompanies an acute dento-alveolar abscess. This usually subsides spontaneously, but it may terminate in an abscess contiguous to the mouth. In the neck it is not so common as adenitis, but some local periadenitis always accompanies a suppurative adenitis.

**Ludwig's Angina.**—In one form, the infection of the cellular planes is so rapid or so extensive as to overshadow the lymphatic involvement. This presents such typical clinical characteristics that it is called Ludwig's angina, after the man who first described it. This is an acute spreading infiltration of the soft tissues, starting in the floor of the mouth and submaxillary region, which binds all the structures into a hard, board-like mass. The swelling is attached to the jawbone on one or both sides and presses the tongue upward and backward in the pharynx. The roof and side walls of the mouth are unyielding, and any hard swelling in the floor must crowd the tongue backward. Though not very common, Ludwig's angina is of great interest, because in the past it has been credited with a mortality of about 40 per cent.

Its existence as a definite clinical entity has been the subject of considerable discussion. We have seen a sufficient number of cases to conclude that it is as definite in its pathology and clinical signs as pneumonia or peritonitis, either of which may be caused by any one of a number of infectious agents. The trouble often starts in a subacute swelling which may remain indolent for some days or weeks, but when it becomes active, the swelling spreads rapidly until the whole floor of the mouth and front of the neck may be involved. At first the skin is not red but pale and immovable on the subjacent swelling, and does not pit on pressure. There is little constitutional disturbance, and though the patient will usually hold the mouth slightly open and may feel more comfortable sitting up, the respiratory impediment may go almost unnoticed. Within the mouth the induration may be felt in the floor on one or both sides, and the submucosa may be so edematous as to rise above the level of the teeth in a gray roll. In this stage resolution may take place spontaneously, but more commonly, if untreated symptoms of grave sepsis develop and the patient survives long enough, there will be discoloration of the skin with diffuse suppuration, or partial gangrene of the deeper tissues. Pneumonia is not an infrequent complication, and if the

swelling extends back into the pharynx, there may be edema of the glottis. Death in from 7 to 20 days is a frequent sequel of the untreated cases. It has been our observation that the most frequent starting-point of the infection of the cellular tissue has been a suppurating submaxillary lymph node or a collection of pus in the floor of the mouth. In all of these cases there is a board-like swelling of the floor of the mouth and grave sepsis with respiratory impediment. It is difficult to obtain pure cultures from abscesses of the mouth, but there is a pretty general opinion that this form of infection is usually due to streptococcus. From the freshly cut tissues in some cases we have obtained a streptococcus in pure culture—less frequently *Staphylococcus aureus.*

## CHRONIC LYMPHADENITIS

Chronic lymphadenitis is usually due to the persistence of some focus within the mouth or pharynx, but at times it would appear as if the infection remained semiactive in the nodes themselves. Usually, after the subsidence of an acute infection, the adenitis disappears, but it may take on a chronic form in which the nodes remain enlarged or may even continue to increase in size. This may occur in one or several groups. On section such enlarged nodes will usually show a simple hyperplasia; and occasionally an abscess may develop. Septic infection of the lymphatic nodes sometimes seems to be the predisposing factor of a tuberculous adenitis.

## CHRONIC CELLULITIS (HOLZPHLEGMON)

Chronic cellulitis is an indolent hard infiltration of the cellular tissue that may be sharply limited and very resistant to treatment, often lasting for months. Unlike Ludwig's angina, it is not confined to the floor of the mouth and front of the neck, but more often attacks the lateral aspect of the neck. It develops slowly and causes few or no constitutional symptoms and little or no suppuration. Fichter reports five cases in which he found numerous pus organisms. We have found the streptococcus and *Staphylococcus aureus* in pure culture in different cases. After persisting for a period of time, the induration subsides, leaving little or no trace of its former presence.

**Treatment of Acute Lymphadenitis.**—Treatment will depend somewhat upon the virulency and extent of the infection. In simple enlargement the nodes themselves need no special attention, even

though they be rather tender, but ice may be applied to the neck; and the intraoral focus should be treated. When from the general symptoms and the periadenitis, with increased local tenderness, it is believed that suppuration has occurred in one or several nodes, these should be opened and drained; and at the same time a culture should be made. In case prompt recovery does not occur, an autogenous vaccine can then be made. If the pus is superficial and definite fluctuation can be detected, the drainage incision may be made directly into the abscess, or, after incising the skin, the fascia may be penetrated with a round-nosed artery forceps, after the plan of Hilton. The opening should be large enough to admit the gloved finger. A counter opening is made at the most dependent point, and a strip of rubber dam is drawn through these two openings, to be left in place until all active secretion ceases. The skin incisions should always be made transverse to the long axis of the neck, when they will leave almost no scar.

**Treatment of Acute Cellulitis.**—The safest treatment of all septic indurations of the floor of the mouth is early free incision. Any particular induration might subside without incision, but one cannot tell which of them is the early stage of virulent infection. If the induration is entirely above the mylohyoid muscle, the incision may be made within the mouth. If it arises in connection with an infected tooth, it is not always safe to extract the latter until the inflammation has subsided. For a deep, extensive induration that can be felt from below the jaw, the incision is usually made best from the outside. We do not mean by this that an external wound is to be made for every infection about the lower jaw. We do believe that deep, hard, septic indurations of the floor can be better drained and more safely approached from the outside than from within the mouth, and that, if the incision is made under the body of the jaw, it will not cause a noticeable scar. The mylohyoid muscle is divided with forceps in the direction of its fibers. In Ludwig's angina, as pointed out by Thomas, there is the double indication of free drainage of all of the cellular planes and of freeing the mouth from the upward pressure in the floor. This we believe can be best accomplished by the incisions shown in Fig. 135.

The skin is infiltrated with a ¼ per cent solution of novocain, and an incision is carried from the tip of the ~~chin to the~~ hyoid bone and from the latter point outward under the angle of the jaw as far as the outer margin of the induration. The median incision and the median part of the lateral incision are carried boldly through the deep fascia,

but as part of the lateral incision might pass over the facial vein and carotid arteries, it is made with more precision. The tissues cut as if they were frozen and bleed but little. A flap is drawn upward,

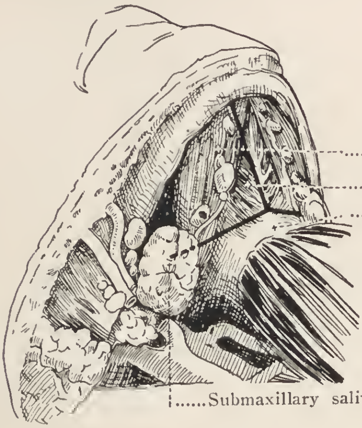



Fig. 135.—Location of the submental and submaxillary lymph nodes. Lines of incisions for dividing the digastric and mylohyoid muscles in an indurating cellulitis of the floor of the mouth.

Fig. 136.—Showing how the tissues open up after making the incision described for Ludwig's angina.

exposing the digastric muscle and the lower part of the submaxillary gland. Here a suppurating lymph node is often found. If there is any induration in the floor of the mouth above the mylohyoid, this

Fig. 137.—Lateral view of patient recently operated for Ludwig's angina, further illustrating how the tissues open up.

Fig. 138.—Patient shown in the preceding figures, eight days after operation. As soon as the induration subsides, the flaps drop back in their normal positions.

muscle and the anterior belly of the digastric are cut through on the lines shown in Fig. 135, when search can be made for pus. In the floor it is usually found along the inner surface of the body of the jaw, but in one case we found it deep in the substance of the tongue. If the induration has crossed the midline, the same incisions are made on the other side, but in no instance are the geniohyoid muscles to be cut. These incisions allow the indurated sections to roll outward, which frees the floor of the mouth (Figs. 136 and 137). In every instance but one, when done early, the operation in our hands has been followed by early recovery. When the induration subsides, the tissues drop back into place, and but a linear scar remains (Fig. 138). If the induration has extended down the neck below the hyoid bone, then a vertical incision is made in the midline, which allows two more triangular flaps to be retracted. In the latter cases careful search for pus should be made among the infrahyoid muscles. In one instance already mentioned, pus was found beneath the thyrohyoid ligament, and recovery took place. The wounds are packed with gauze and are never sutured. Extreme restlessness may result from sepsis, but it is often caused by partial obstruction to respiration. If after proper incisions in the floor of the mouth restlessness persists, which is not relieved by a sedative, but is partially relieved by allowing the patient to sit up, then tracheotomy is to be considered, and if one can be satisfied that the respiratory impediment is not due to pneumonia, the tracheotomy should not be delayed too long.

These patients should have general supporting treatment and sleep.

**Treatment of Chronic Lymphadenitis.**—The first indication is a search for some septic focus that can be keeping up the irritation in the lymph nodes; and the general hygiene of the patient is to receive attention. In the rare instances where single groups of nodes continue to enlarge without apparent cause, it is often well to dissect these out *en masse*. All pathological enlargements are to be regarded with suspicion. If the enlargement is due to an encapsulated septic infection, it is well to have it out, but it is not improbable that on section it will be found that some graver change has occurred—such as tuberculous infection—or even that the growth is due to an actual tumor of the nodes. Before making such an excision, the surgeon must satisfy himself that the enlargement is not simply a part of a generalized disease of the lymphatics, such as Hodgkin's disease, and is not secondary to some other focus.

These dissections are often made very difficult by the scarring that has occurred in the periglandular tissue. After the removal of the

mass of chronically diseased nodes, the wound is to be closed with proper drainage, which latter is to remain in place as long as there is any active secretion. In non-suppurating cases this may be about a week.

**Treatment of Chronic Cellulitis.**—Chronic cellulitis has been found to be remarkably resistant to all ordinary forms of treatment and seems to be little affected by drainage incisions. The usually favorable outcome of the disease hardly warrants extensive deforming incisions, and the latter have, apparently, comparatively little effect. It seems to us that the most promising treatment is to obtain an autogenous vaccine, obtained by incision and culture, and after protecting the patient by appropriate doses, to encourage the circulation through the inflamed area by cupping (Bier's hyperemia).

## CHAPTER XIX

## DISEASES OF THE MAXILLARY SINUS

The maxillary antrum is an accessory sinus of the nose, occupying the body of the maxilla. At birth it is rudimentary and attains full development at the twelfth year. It is bounded above by the floor of the orbit, internally by the lateral wall of the nose, anteriorly and externally by the anterior and lateral walls of the maxilla; while the floor is at the base of the alveolar process. The cavity occasionally extends over the hard palate for variable distances, even to the mid-line. It is lined with muco-periosteum and ordinarily communicates with the nose by an aperture high up in its inner wall—the *ostium maxillare*—which opens into the middle meatus. The cavity normally contains air and is lined with ciliated epithelium which carries the mucous secretion upward and outward through the nasal opening. The cavity is sometimes divided by incomplete bony septa. The apices of the roots of the molar and second premolar teeth are usually in close relation with the floor. In some cases the apices rise above the floor, covered only by the mucous and the peridental membranes. Occasionally the canine and first premolar teeth have a similar relationship. The maxillary sinus varies very much in form and size in different individuals, and this may be the case on the two sides in the same individual. It is important to bear all of these facts in mind in the diagnosis and treatment of maxillary sinus diseases.

Although the antrum may be the seat of numerous surgical diseases, infection followed by suppuration due primarily to pus organisms, or secondary to some one of the exanthemata or la grippe, is so common as to overshadow all other lesions combined.

### ANTRAL INFECTION

**Suppurative inflammation** or **empyema** of the maxillary sinus may be caused by infection extending from the nose and associated air cells, or from penetration of bacteria and their products through the floor of the antrum as a result of dento-alveolar abscess or pyorrhea alveolaris. Any part of the wall can be invaded by syphilis or tuberculosis which may ulcerate into the antrum, but this is of much rarer occurrence. Suppurative inflammation may be acute or chronic.

**Symptoms of Acute Empyema.**—As in any acute pus infection, there may be fever, leucocytosis, and an increased percentage of polymorphonuclear cells in the blood. These symptoms are especially likely to occur if the pus is confined by obstruction of the natural opening. With confined pus the most characteristic and constant subjective symptoms are pain and tenderness over the affected side of the face. The pain may occur in the guise of a headache or a referred neuralgia. Frequently the side of the face will be much swollen, and the lower eyelid edematous. There may be a history

Fig. 139.—Antero-posterior radiogram, showing cloudiness of right maxillary sinus, due to suppuration.

of a diseased tooth on the affected side, and examination may reveal it. Breathing through the nose on that side may be impaired or completely obstructed. If the ostium maxillare is open, a flow of pus can usually be obtained from the nostril by holding the head downward and forward with the affected side uppermost.

**Transillumination Test.**—If a small electric light is placed in the mouth while the patient is in a dark room, the light is transmitted through a normal antrum and shows as a red crescent on the front of the cheek and lower eyelid. When there is fluid in the antrum, there is a lessening or obliteration of the red crescent of

light. This sign may be misleading, as the antrum may be small in size, and one antral wall may be thicker than the other.

The x-ray is a valuable aid in diagnosis, a cloudiness of one side often indicating maxillary sinus disease. An anteroposterior x-ray plate is necessary in these cases, so that comparison of the two sides may be made (Fig. 139). The x-ray also in many cases of dental origin will show a direct communication of the offending tooth with the maxillary sinus. Here an intraoral film is of value (Fig. 105).

The diagnosis may be confirmed or disproved by puncturing the antrum, under local anesthesia, either through the nasal wall under the inferior turbinate with a heavy needle or a trocar, or through the canine fossa with a bur. The puncture may be made through the socket of a diseased tooth after extraction, but a healthy tooth should never be extracted for this purpose.

**Symptoms of Chronic Empyema.**—Chronic suppuration of the maxillary sinus may be accompanied by little or no pain or swelling, and the only symptom may be a flow of pus from the nostril on the affected side, or an opening into the mouth. Here also, transillumination, x-ray examination, and puncture may be of value in making the diagnosis.

In some cases of chronic inflammation of the antrum of dental origin, a mass of inflammatory tissue grows upward into the sinus from around the root of the offending tooth, with very little actual suppuration. Here the ordinary symptoms and signs of antrum disease may be absent. There may be little or no pain or tenderness, no flow of pus from the nostril, the needle puncture through the nose with irrigation may be negative. Diagnosis frequently rests on x-ray of the molar root ends in proximity to the floor of the sinus.

**Treatment.**—It will be readily understood that the maxillary sinus is a common field which must be invaded by the oral surgeon and the rhinologist. It is becoming more and more recognized that the rhinologist, with his special facilities for diagnosis and for doing intranasal operations, is the one most fitted for the treatment of at least those cases which are secondary to a nasal infection or which require intranasal drainage. If the infection of the cavity is dependent on intranasal disease or on disease of other sinuses, it is perfectly evident that these as well as the maxillary sinus should be treated. A skilled rhinologist is the only one competent to treat diseases of the upper nasal sinuses. On the other hand, if the disease is an extension from around a tooth, it is just as important that this source of infection be eliminated.

**Treatment of Acute or Subacute Antral Infections of Dental Origin.**—The antrum may be infected directly from a root canal. More often the infection is secondary to an alveolar abscess. In either case the offending tooth should be extracted. Conservative treatment of the tooth should never be attempted, as sufficient drainage cannot be obtained through the root canal, and the latter can never be put into a permanently healthy condition. After extraction of the tooth, the opening into the antrum may be made larger by drilling through the socket with a surgical bur. The cavity should be irrigated with normal saline solution, or weak solution of potassium permanganate, once or twice a day until all signs of suppuration have disappeared. The opening should be kept lightly plugged with a strip of gauze. Insertion of a drainage tube is apt to encourage chronic infection. In a subacute infection the discharge may persist for a month to six weeks; but a discharge from the cavity persisting longer than six weeks, after free drainage is furnished, should be considered chronic, and permanent drainage through the nose is indicated. Before this is undertaken, it should be ascertained whether any of the upper nasal sinuses are infected, for pus pouring into the middle meatus may constantly reinfect the antrum if the natural aperture is patent.

**Treatment of Chronic Antral Infections.**—When the suppuration becomes chronic, permanent drainage from a dependent point, with the removal of hopelessly diseased tissue, is the only treatment which has been found to give permanent relief. Attempts to establish permanent drainage into the mouth have been common, but the constant use of drainage tubes tends to continually reinfect the antrum. This method is being discarded for the nasal route, as more nearly approaching the natural physiological and anatomical conditions. In chronic suppuration there may be partial or complete destruction of the surface epithelium or the whole mucous membrane, or it may be thickened and infiltrated with fibrous tissue. It may be covered with granulations or the antrum may contain polypi, denuded bone, or mucous cysts. Polypi are pedunculated growths from the mucous membrane, and contain cystic areas filled with mucus. They are felt as soft masses that bleed easily. Before performing an operation to establish permanent nasal drainage, any infected teeth communicating with the maxillary sinus must, of course, be removed.

Operations for the relief of chronic antral suppuration fall into two general classes: those which provide permanent intranasal drainage, which may be called conservative; and those which furnish free access to the cavity whereby diseased tissue may be removed with a

curette. In the great majority of cases permanent relief will be obtained by one of the operations which are collectively styled the Mikulicz, which consist in establishing a large permanent opening between the antrum and the nose through the inferior meatus. Schaeffer was the first to describe the method of puncturing the antrum through the lateral wall of the middle meatus. Various technics have been devised, most of them including the removal of part of the inferior turbinate bone. The most effective of these is the operation described by Sluder. It provides the largest opening, and at the same time is the most conservative, for it preserves the inferior turbinate bone intact. While perfect access for curetting the antrum cannot be obtained by the Mikulicz operation, it is a question whether curetting is often necessary. Free permanent drainage being provided there rarely remains anything to keep up the irritation; dead bone will be thrown off, polypi, which are inflammatory growths, will at least cease to grow, and the mucous membrane will have the best chance to regenerate. Discretion is to be exercised in curetting the interior of the antrum. Polypi, dead bone, and heavy, coarse granulations may be removed, but the small granulations are to be let alone in the hope that the deeper epithelium, lining the mucous follicles, may eventually cause a reepithelization of the surface. If the mucous membrane is entirely destroyed or removed, then, unless a flap is transplanted from the nose, the cavity can be lined only with scar tissue.

Küster Operation.—The older radical operation of entering the antrum through a large opening made in the canine fossa and, after removing granulations, polypi, or dead bone, packing or treating the cavity for a period will be successful in a number of cases, but not in all; for the opening will eventually close, and the suppuration is liable to recur. It is sometimes called the Küster operation and is performed as follows:

An incision is made down to the bone over the canine fossa in the upper fornix. The soft tissues, including the periosteum, are raised with an elevator, and the anterior wall is removed with a perforator and biting forceps until the opening is 1½ centimeters in diameter. Then a light is thrown into the cavity; and all diseased tissue is removed, and any septa present are broken down. The cavity is loosely packed with gauze saturated with compound tincture of benzoin, the end of the gauze protruding into the fornix. Subsequently the cavity is irrigated daily, and when suppuration ceases, the wound is allowed to close.

Caldwell-Luc Operation.—The Mikulicz operation has been combined with the Küster under the name of the Caldwell-Luc operation, which is really a radical procedure giving free access to the cavity and also providing permanent drainage. In this operation the diseased tissue is removed, and the mucous lining of the inferior meatus is turned into the floor of the antrum. Then the opening through the canine fossa is immediately sutured, and all further treatments are carried on through the nasal opening. It is difficult even by this means to remove granulations or diseased bone from the anterior inferior angle of the cavity, and these may cause the infection to persist.

Denker Operation.—The Denker operation overcomes this difficulty, gives free access to the sinus, provides permanent intranasal

Fig. 140.—Denker operation for chronic antral infection.

drainage, and for its performance does not require the special technical skill which is needed for an intranasal operation done through the anterior nares. It should, therefore, appeal to the general surgeon as most appropriate for all cases of chronic antral suppuration requiring radical treatment. The technic of the operation is as follows:

The operation is best done under a general anesthetic. The patient is placed in the Rose position with the head hanging over the end of the table, but supported by an assistant. Postnasal tamponage may be used, but if the head hangs well downward, this is not necessary. The labiogingival incision is made as in the Küster operation, but extends to the median line. The soft tissues, including the periosteum, are elevated, the antrum is opened through the canine fossa, and the lower part of the bridge of bone, between the antrum and

the opening of the nose, is removed. This piece of bone is thick and will require strong biting forceps. By this the anterior inferior angle is opened, and the whole cavity is accessible to the curette. Bony partitions should be removed along with such pathological tissue as may seem expedient (Fig. 140). If there is to be a mucous flap turned from the nose to the floor of the antrum, its future site should be freed of all mucous membrane; otherwise mucous follicles might be buried under it and give rise to cysts.

The next step in the Denker operation is to free the mucoperiosteum from the bony wall of the inferior meatus and from the under surface of the inferior turbinate bone. Having incised the mucoperiosteum, it is elevated and converted into a flap, to be turned

Fig. 141.—Denker operation for chronic infection of the antrum, showing the permanent opening between the antrum and the nasal fossa through the inferior meatus. The upper dotted line indicates the height to which the lateral wall is removed, most of the opening being hidden by the inferior turbinated bone.

outward into the floor of the antrum. Finally, the bony wall of the inferior meatus, with the mucous covering on its antral side, is removed with biting forceps (Fig. 141). The flap of nasal mucoperiosteum is then turned into the floor of the antrum and held in place for twenty-four to forty-eight hours with an antiseptic gauze pack, the end of which protrudes from the nostril. The wound in the vestibule of the mouth is immediately closed with sutures.

In doing this operation, it is unnecessary to sacrifice any part of the inferior turbinate bone, which is a functional structure. Ballenger calls attention to this objection in almost all of the opera-

tions that give permanent intranasal drainage. In the cases upon which we have operated for chronic antral suppuration, we have never found it necessary to remove any part of this bone. By removing the outer wall of the inferior meatus up to the attachment of the inferior turbinate, ample room is obtained. In making the window into the inferior meatus, the lower part of the nasal duct may be injured. It opens at a variable distance below the attachment of the inferior turbinate bone, 30 to 35 millimeters from the posterior boundary of the nostril, which is about at the junction of the anterior with the middle third of this bone.

## CYSTS OF THE ANTRUM

The antrum may contain free mucus from simple obstruction of its nasal opening, or it may be partially or completely filled by a mucous cyst, due to the distention of one of its contained mucous

Fig. 142.—Calcified wall of a cyst in right antrum, communicating with the socket of two bicuspid teeth. (Hunterian Museum, London. Photographed for this book by courtesy of the curator.)

follicles. A dental cyst might extend into the antrum. Occasionally the wall of the cyst becomes calcified (Fig. 142). The mucus will obstruct both transmitted light and x-ray, and the pressure of the cyst may cause pain. Later a cyst may thin and distend the walls of the antrum. It is to be differentiated from chronic suppuration by making a puncture.

**Treatment.**—This consists in furnishing a permanent outlet to the mucus. If it is due simply to the closure of the normal outlet, a

supplementary one should be made in the inferior meatus. If the distention is due to a cyst, the antrum should be opened, and the free part of the cyst wall excised.

## TUMORS OF THE ANTRUM

Fibromata, osteomata, or sarcomata may arise in the cavity from its walls; epitheliomata from its contained or a contiguous mucosa; odontomata, cystic or solid, or a tooth may grow into it. Benign tumors distend or cause absorption of its walls, while malignant tumors infiltrate. (For symptoms of tumors of the antrum see Examination, page 40.)

**Treatment.**—Benign tumors are to be removed, after opening the antrum, from within the vestibule of the mouth; while malignant growths will demand the total or partial removal of the maxilla, depending upon their size and location.

# CHAPTER XX

## TUMORS OF THE MOUTH AND JAWBONES

Nearly all of the tumors and cysts which can arise in any part of the body may be found in or around the mouth, except those which are peculiar to certain extraneous organs. There are also certain tumors and cysts which are peculiar to this region.

### HYPERTROPHY OF THE GUMS

Though probably not a tumor in the strict sense of the term, it is convenient to present hypertrophy of the gums with the tumors of this part.

By the term hypertrophy is meant an overgrowth of tissue in which the individual cells maintain their normal physiologic functions. In the gums it may be localized or involve all of the gingival tissues. Localized hypertrophy may be due to mild irritation of some kind continued over a long period of time. A badly fitting plate may cause the gum tissue in the anterior part of the mouth to grow down between the plate and the front of the bony ridge, giving the appearance known as "double lip." A badly fitting crown or clasp may set up irritation about the neck of a tooth, thus causing hypertrophy of the gum. In the same way a carious cavity in a tooth often becomes filled with hypertrophied gum tissue.

In the **treatment** of localized hypertrophy of the gums, the first thing to do is to remove the cause. The excess of tissue may then be excised under local anesthesia and the edges of the wound brought together with a suture.

*Generalized hypertrophy of the gums* appears usually in children, and all of the cases we have seen or heard of have been in children or young adults. The cause is unknown, but it is possibly due to a nutritional defect and related to scurvy. The overgrowth of tissue may enlarge until the teeth are buried and the whole mouth is filled. Sometimes an inflammatory reaction takes place in the hypertrophied tissue from infection, giving rise to free bleeding at the slightest touch. The teeth may be loosened and displaced. Inability to take proper food and toxic absorption from the mouth may produce a greatly weakened general condition (Figs. 143 and 144).

Microscopic examination of excised gum tissue shows a normal covering of epithelium, the bulk of the growth being composed of delicate wavy fibrous bundles. Frequently areas of myxomatous degeneration are seen.

*Treatment* consists in removal of the hypertrophied gum tissue together with the underlying alveolar process and loose teeth. It may

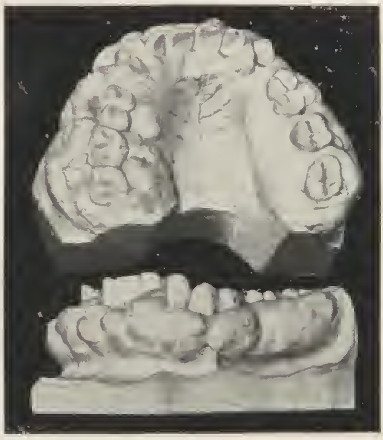


Fig. 143.—Hypertrophy of the gums.—By courtesy of Dr. Prinz.

Fig. 144.—Generalized hypertrophy of the gums.

be necessary to operate in stages, removing only a portion at a time, owing to the large amount of hemorrhage and the patient's weakened condition. If the operation is performed thoroughly, recurrence is unusual. Cryer illustrates a case in which he removed the gums, alveolar processes and teeth in both jaws. Fig. 143 presents a less advanced case, observed by Dr. Herman Prinz.

## TUMORS

**Epulis.**—Clinically speaking, a tumor occurring upon the gum is known as an *epulis,* but this term does not express the pathological condition present and may embrace a considerable variety of growths. The characteristics common to all epulic tumors are circumscribed growth from the alveolar ridge, attached with a broad (sessile) or narrow (pedunculated) pedicle, and covered over by normal mucous membrane, except as the latter may undergo secondary ulceration due to pressure necrosis, infection, etc.

Epulides are all essentially connective tissue tumors and may be classified as follows:

(a) Fibroma
(b) Angioma
(c) Endothelioma
(d) Giant-cell tumor (Giant-cell myeloma)

**Fibrous Epulis.**—The fibroma is the most prevalent form of epulis. It appears as a hard nodular mass upon the surface of the gum or

Fig. 145.—Epulis.

pushing out between two teeth, sometimes displacing the teeth, with a clear line of demarcation where the bulging of the new growth extends beyond the normal contour of the gum. The attachment of the gum may be almost as broad as the tumor itself, when we speak of

it as *sessile,* or there may be a narrow pedicle, with the tumor spreading over the surface of the gum, when it is termed *pedunculated.* In color, the mucous membrane covering the tumor may be slightly reddened, though it often differs but little from that of the normal gum (Figs. 145, 146, 147). Fibromas are nearly always slow in growth, altering in size but little in months or even years. Microscopically,

Fig. 146.—Epulis.

Fig. 147.—Epulis.

we see an outer layer of normal stratified squamous epithelium and submucosa, while the deeper portion of the growth consists of an interlacing network of fibrous tissue with round-cell infiltration (Fig. 148). Occasionally, there is evidence of myxomatous degeneration, and sometimes of bone formation. These growths spring from the periosteum of the alveolar process or from the peridental membrane.

The **treatment** consists in the extraction of teeth loosened or displaced by the growth, or from whose peridental membrane it is sup-

posed to arise, excision of the growth itself, and of the underlying periosteum and alveolar process. Recurrence is likely to follow if the place of origin is not thoroughly eradicated. Operation may usually be performed under local anesthesia.

**Angioma.**—This form of epulis is usually softer, having more of a spongy character than the pure fibroma. It grows more rapidly, the overlying gum is bright red in color, and it bleeds easily. Microscopically, under the covering squamous epithelium is seen a large amount of fibrous tissue containing numerous dilated capillary blood vessels (Fig. 149). The origin of these growths is the same as in the case of fibromas, and the *treatment* is the same. Excision of

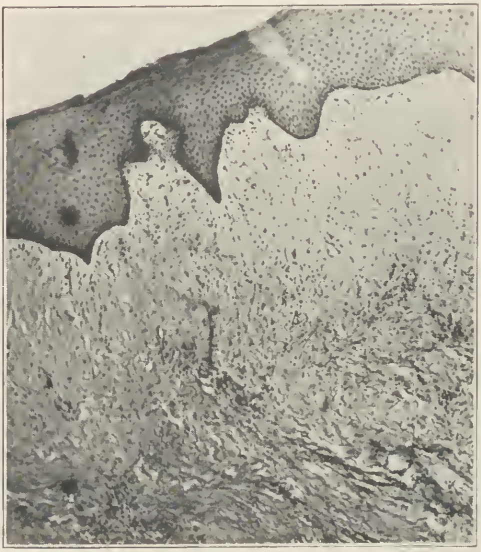


Fig. 148.—Photomicrograph of fibrous epulis.

angiomas may be attended with considerable hemorrhage, requiring packing or even use of the cautery.

**Endothelioma.**—Occasionally, in the tumors that are essentially fibromatous, there are seen strands or masses of cells proliferating from the endothelial lining of the vessels, in which case the tumor is termed an *endothelioma* (Fig. 150). Here, there is more tendency to recurrence after removal than in pure fibroma.

**Giant-cell Epulis.**—This, next to the fibroma, is the most common form of epulis. The clinical characteristics of a growth of this type are a smooth, soft, dark red or purplish swelling on the gum surface, with a broad or narrow pedicle, loosening or displacing the teeth, and

increasing rather rapidly in size. Microscopically, beneath the covering mucous membrane there is a stroma of fibro-cellular tissue and scattered throughout are giant-cells, which vary in size and have numerous nuclei grouped toward the center of the cell. Small masses

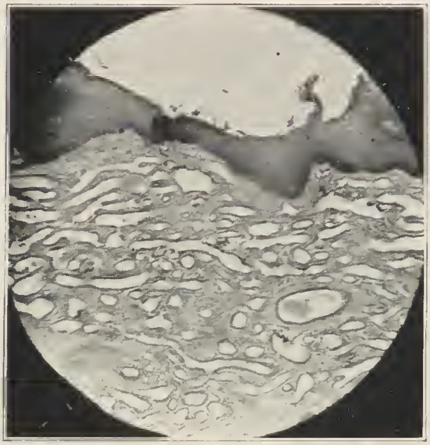


Fig. 149.—Photomicrograph of angioma of gum.

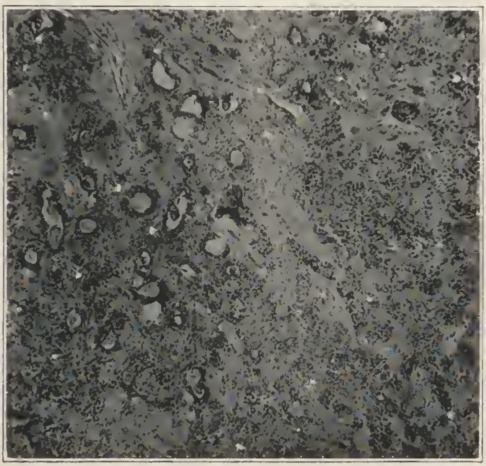


Fig. 150.—Photomicrograph of endothelioma.

of bone and cartilage may be found (Fig. 151). There is considerable confusion as to the proper classification of these growths. The term commonly used is giant-cell sarcoma, but the word sarcoma implies malignancy, and these growths are not malignant in the true sense of the word. Giant-cell myeloma is perhaps a better term, because the

giant-cells are similar to those found in bone marrow and periosteum. The unfortunate application of the term "sarcoma" to the ordinary giant-cell tumors of the jaws has led to much unnecessary sacrifice of tissue, deformity and functional disability by the performance of extensive operations, such as opening the face and complete section of the lower jaw.

**Treatment.**—The simple treatment of thorough local removal of the growth and underlying alveolar process is usually sufficient to prevent recurrence. Metastasis is never seen. These cases commonly give a history of having had the growth cut off one or more times, with recurrence because the underlying process was not removed.

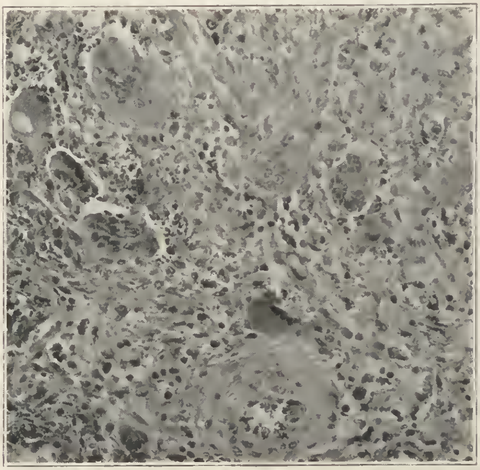


Fig. 151.—Photomicrograph of giant-cell myeloma.

Occasionally, these giant-cell growths are not so sharply circumscribed, grow rapidly, and histologically, instead of the usual fibrocellular stroma, there is present a proliferation of the endothelium of the blood vessels, forming the bulk of the stroma, which contains numerous giant-cells (Fig. 152). Here we are dealing with a more malignant form of growth, requiring a more extensive operation to avoid recurrence.

Sometimes, these giant-cell tumors appear to spring, not from the periosteum on the surface of the alveolar process, but from the deeper parts of the bone. Here there is a bulging out of the lingual and buccal alveolar plates with a dark red spongy growth projecting above the gum surface. The radiograph shows a well circumscribed area of bone destruction involving the body of the bone. In these deeper

cases the neoplastic tissue can frequently be shelled out easily from the bone cavity.

Growths of epithelial origin may appear upon the gum surface and resemble true epulis in this respect. Two types occur, papilloma (benign), and carcinoma (malignant).

**Papilloma** may appear as a nodular or oval growth on the surface of the gum. It may either simply represent a localized thickening of the epithelium or under the microscope the submucosa may exhibit projections covered with epithelium. These growths do not arise from the periosteum and in treatment it is not necessary to remove

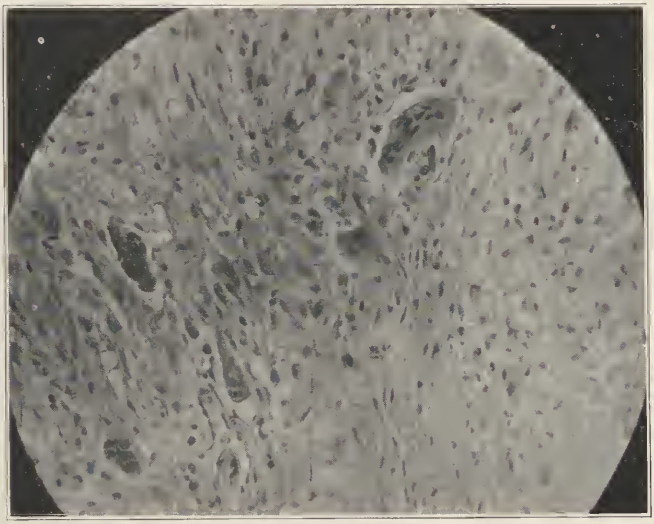


Fig. 152.—Photomicrograph of giant-cell myeloma, endothelial type.

any of the underlying bone. Papillomas may also be found on the mucous membrane of the cheek, lip, tongue or palate.

**Carcinoma** sometimes appears in the form of epulis as a cauliflower-like growth. It usually occurs after 40 years of age. The epithelial cells of an originally benign papilloma or fibroma may start to proliferate and invade the deeper connective tissues and break down and ulcerate.

The **treatment** here is that of carcinoma elsewhere—radical removal of the tumor with the knife or cautery together with a wide area of the surrounding healthy tissue and blocking off the neighboring lymph nodes by x-ray or radium.

## OTHER TUMORS AFFECTING THE JAWBONES AND SOFT TISSUES OF THE MOUTH

**Fibroma.**—Besides the pedunculated form which comes under the general term of epulis, fibromata may develop either from the periosteum or from fibrous tissue contained within the bone. In the former case it will appear as a slow-growing nodule, attached by a broad base; in the latter it will cause expansion and finally perforation of the bone. They often appear to arise in connection with some trauma and grow very slowly. The diagnosis is made mostly on their slow growth and distinct nodular outline, also on their consistence, which is less hard than bone or cartilage. All new growths should be regarded with suspicion and, wherever possible, subjected to microscopical examination. If the tumor takes on active growth, it should be treated as malignant and removed with a section of the bone to which it is attached, but the full thickness of the lower jaw is seldom to be removed.

**Chondroma.**—A chondroma is a tumor composed of hyaline cartilage and, according to Bland-Sutton, grows from preexisting cartilage; occurring in relation to the upper jaws, they may arise from the cartilaginous septum of the nose. They are encapsulated and nonmalignant, and cause distress only by their size and relations. They occur most commonly in children and young persons and are usually small, but may rarely attain a relatively large size. Pathogenically they are to be distinguished from the more rapidly growing, infiltrating chondrosarcomata, which grows to a large size. They should be excised with the cartilage from which they grow.

**Osteoma.**—These tumors are composed of bone, surrounded by a layer or cap of cartilage—therefore, ossifying chondromata. They occur on any part of the bones of the face, but probably more commonly on the upper than the lower jaw. They may be of compact or cancellous bone, and may be pedunculated or attached by a broad base. They grow very slowly, but may attain a large size. As they grow, the soft tissues covering them may ulcerate, leaving the bone exposed. They are painless, but pain may be caused by pressure. When pedunculated, they may become detached and be thrown off spontaneously. They are nonmalignant (Fig. 153). Detached bony masses have been found in a soft tumor—possibly a sarcoma. They are to be distinguished from osteo- or bone-forming sarcomata, from tumors that expand the bone, and from leontiasis ossea, which latter is a thickening of, not a growth from, the bone. Treatment consists

in their removal, together with a very small area of the bone to which they are attached.

**Myxoma.**—The pure myxoma is rare. Myxosarcoma, which is more common, is a flat, soft tumor of much more rapid growth. The indications are for a complete removal, rather than a partial operation.

**Sarcoma.**—Several varieties of sarcoma occur in connection with the jaws. They may be of the spindle, large, or small round cell, or the somewhat doubtful alveolar variety; or the growth may be mixed in the character of the cells which compose it. Any of them may contain sufficient fibrous tissue to make this a characteristic of the growth, or they may form bone or cartilage. Rarely, melanotic sar-

Fig. 153.—Osteoma of ivory-like texture, attached to the angle of the lower jaw (Hunterian Museum, London. Photographed for this book by courtesy of the curator.)

comata of the upper jaw have been observed. The histological character will often give some clew to their virulency. The large round, the spindle, and the small round varieties vary in malignancy in the order named, the large round cell tumor being least so. The greater the proportion of fibrous tissue, the less the malignancy. The sarcomata that form fibrous, osseous, or cartilaginous tissue are composed of cells which have the power of developing beyond the purely embryonal stage, and it is probable that they are in general less malignant. Melanotic sarcomata are the most malignant of all. The relation of the cells to the blood vessels seems to have some bearing on this subject, those tumors in which the cells are crowded close to the vessels being more malignant than tumors in which the cells are separated from the vessels by some fibrous tissue.

Sarcomata arising from the periosteum are usually rather firm in consistency, while those arising from within the bone are often very soft. Scudder states that periosteal sarcoma does not arise in the alveolar border, but from the body of the bone. It is often stated

Fig. 154.—Endosteal sarcoma of body of mandible in child.

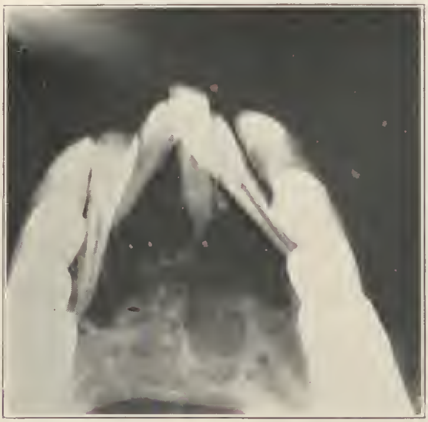


Fig. 155.—Endosteal spindle-cell sarcoma of symphysis of mandible in child. Note displacement of teeth.

that the periosteal varieties are less malignant than those of endosteal origin. The periosteal varieties cause hard, irregular, usually somewhat fusiform swellings. Certain of the true sarcomata, which grow within the body of the bone, causing a thinning and bulging rather than infiltration of its walls; and from personal observation, we are

certain that they are among the more mildly malignant. (Figs. 154, 155, 156.) In the upper jaw periosteal sarcomata may arise within, or endosteal sarcomata may invade the maxillary antrum, causing at first a thinning and bulging of its walls, but later a perforation and involvement of the soft tissues by direct extension. Sarcomata of the mouth may cause enlargement of the lymph nodes, but with the exception of the lymphosarcomata, more often from septic absorption from the ulcerated surface than from an extension of the disease. Sarcomata seldom cause pain, at least in the earlier stages, though they may do so by pressure of nerve trunks. The diagnosis should always rest upon a microscopical examination, to which it is a safe plan to subject every tumor. The various clinical symptoms which are ascribed to different tumors and different varieties of sarcomata may be misleading in the individual case, and if depended upon for

Fig. 156.—Periosteal sarcoma of maxilla in elderly woman.

diagnosis, may cause unnecessary mutilation or a disastrous delay. No age is exempt from this disease. Coley attributes acute trauma as a cause in 23 per cent of his 970 cases. Some fungate and ulcerate early, while others attain immense size without ulcerating. In some varieties the growth is rapid from the first; while in others it may be slow or remain in abeyance for years, only to take on a rapid growth.

**Treatment.**—With the exception of certain slow-growing, large round cell varieties, the treatment of all operable tumors is a radical excision *en masse*, of all involved tissues well into the healthy structures. The lymph sarcomata will demand the removal of the lymph-bearing tissue of the regions which drain the infected area. It is not always necessary or advisable to remove a whole or half of the jawbone, but the excision should be made from 1 to 1½ centimeters from the tumor all around, regardless of the tissue involved; and where possible, the lower border of the bone should be preserved.

If too far advanced to attempt radical treatment, the operation should be made as complete as possible, as some of these growths, especially the large round cell variety, return very slowly after an incomplete removal. This may be true even of the mixed small and spindle cell tumors. In large slow-growing tumors of the lower jaw which cause a distinct expansion of bone and can apparently be shelled out of the bone, we believe that this is a better treatment than a very extensive resection. Such tumors are usually composed of large, round cells and much fibrous tissue, and are slow to return after being removed in this way. The lateral bony walls of the cavity may be excised with their periosteal covering, but at least a thin bridge of bone should remain to preserve the outline of the lower jaw. Gilmer has reported a number of satisfactory results with such tumors treated in this way. In all cases we would recommend the use of Coley's fluid, pushed to the limit of endurance for a long period after every attempted removal of a sarcoma. We have had the satisfaction of seeing several inoperable, or unoperated, sarcoma held in abeyance for a number of years, after the use of the Coley's fluid. (We have found the fluid prepared by Dr. Martha Tracy the most active.) If accessible, radium may be used.

In all cases of sarcoma the ultimate prognosis is bad, even if removed early. But recurrence may not take place for a long time, or the patient may die from metastasis of the lungs before there is local recurrence. However, metastasis from jaw sarcomata is rarer than from other sarcomata.

**Myelomata** were formerly classed as sarcomata, but are not malignant in that they do not cause metastasis and will not recur after a thorough removal. They arise only in the alveolar tissue of the bone and are composed for the most part of giant cells, with an intermixing of spindle and round cells. The tumor presents the appearance of freshly cut liver. According to Bland-Sutton, they occur in the body of the mandible and the alveolar process of the maxilla. They rarely occur after the age of twenty-five, grow slowly, and expand the bone as they advance. Sometimes they later perforate the bony capsule and invade the soft tissues.

The diagnosis of myeloma rests upon the clinical features cited, and a microscopical examination. For their treatment they do not require mutilating operations; but the bone is to be opened, and the tissues scraped out. If they have perforated the capsule, this portion should be removed by an excision extending into the healthy tissue.

**Carcinoma.**—Carcinoma of the mouth and jaw is principally a disease of elderly persons. It arises from epithelium, and in most

instances comes primarily from the mucous covering of the gums, tongue, or lining of the antrum. Another possible source is from the embryonic epithelial cell-rests in the peridental membrane, originally derived from the enamel organ.

Most carcinomas of the mouth seem to arise in connection with mechanical or dental irritations. Leucoplakia is responsible for some, and in this connection smoking must be regarded as a factor. Consequently, carcinoma about the mouth is 12 to 15 times more common in men than in women. Broadly, there are two clinical types of carcinoma seen in the mouth, the hard, ulcerating type, which usually appears in the lower jaw and tongue (Fig. 157), and the soft, medullary type, which is found in the antrum and upon the oral surface of

Fig. 157.—Carcinoma of lower jaw.

the upper jaw, presenting a cauliflower appearance. Carcinoma of the lower jaw and tongue causes earlier evident involvement of the lymph nodes than does carcinoma of the upper jaw. This may be due to the fact that most of the lymphatics leading from the upper jaw empty into the internal maxillary and retropharyngeal nodes, which are not palpable, while those from the lower jaw empty into the submaxillary and cervical nodes. Inability to palpate enlarged lymph nodes in the neck should never be taken as evidence that they are not involved.

Microscopically, carcinoma of the mouth is usually of the squamous prickle-cell variety, though basal-cell tumors do occur.

The majority of all cases can be traced to leucoplakia or some local irritation, and syphilis is supposed to be a strong predisposing factor.

Owing to their accessibility and the sensitiveness of the mouth, the whole progress of these cancers can be observed better than in any other location except the skin. Some of the precancerous lesions exist for years, some for a few months. The actual cancers themselves as a rule are rather indolent at first. A smaller number show rapid growth from the first and the lymph nodes have been known to become infected within three weeks after the appearance of the initial lesion.

The virulence of cancer of the mouth varies in different locations; and as a general rule the operation becomes more serious the further back in the mouth the growth occurs.

The original site of cancer of the mouth may be the lip, especially the lower lip, the tongue, the cheek, the gum of the lower jaw, the gum of the upper jaw, the floor of the mouth, the palate and the fauces. From these sites it may spread to the jawbones proper and to neighboring structures.

**Precancerous Lesions.**—The most common of precancerous lesions is leucoplakia. Others are chronic fissures of the lip, herpes, injury or mechanical irritation from sharp edges of teeth, artificial dentures, and benign warts and other growths.

**Leucoplakia** is a white patch in the mucous membrane, resembling somewhat a patch of enamel paint (Bloodgood). On palpation it is distinctly recognized from the surrounding mucous membrane; it is harder and leathery in consistency. It is practically always associated with excessive use of tobacco. As a rule, these patches first appear at the angle of the mouth and behind the molars, at the tip and along the borders of the tongue. In the later stages the patches show a tendency to crack or peel off, resulting in fissures or ulcerations, becoming painful. These later signs should convey a warning of the probable onset of cancer.

Microscopically, in leucoplakia there is seen a heaping up or thickening of the outer layers of squamous epithelium.

**Treatment of Leucoplakia.**—One should explain to the patient why the use of tobacco should be discontinued in all forms. The patient should be placed under the care of a dentist and directions should be given to wash the mouth frequently with a solution of sodium bicarbonate. He should be required to return for repeated examinations at stated intervals, until it is well established that there is no area which requires excision (Bloodgood). Local treatment of leucoplakia by radium, roentgen rays, or any irritating caustic is contraindicated. The cause must be removed first. Then, if the leucoplakia progresses, becomes fissured, ulcerated or painful, it should

be excised with a good margin of healthy tissue with the cautery. Special attention must be called to the evil effects of the use of irritants upon cancerous or precancerous growths. The most pernicious and prevalent one is the application of silver nitrate. Histories of many cases show that after such treatment latent indolent growths have been stimulated into most virulent activity.

The unfavorable outcome of carcinoma of the mouth is chiefly due to largely avoidable procrastination and partly on account of pernicious treatment. When the public is taught the advisability of consulting a physician or a dentist in regard to every localized thickening, discoloration, crack or ulceration that appears within the mouth which persists for more than a few days; when the physician or dentist consulted will bend his efforts toward making an accurate diagnosis rather than dismissing it as inconsequential or tentatively using various irritants in an attempt to cure it; when patients of cancer age with leucoplakia or other chronic epithelial change are warned of the danger of cancerous degeneration and of the frequently insidious nature of the onset of the change; then, and only then, will results of treatment for cancer of the inside of the mouth compare favorably with the results obtained in other regions. The onus of responsibility in this matter rests chiefly upon the dentist. There are few persons in this country who do not consult a dentist, not only once, but repeatedly. It is during what is termed the cancer age that the teeth are disintegrating or artificial teeth are worn. Until the much desired cancer specific is discovered, it is mainly to the educated dentist, grounded in oral pathology, who makes a complete survey of the whole mouth, that the medical profession and the public must look to reduce the now increasing death rate from cancer of the mouth.

**Clinical Stages of Cancer of the Mouth.**—It is convenient in presenting the subject to divide the stages of the growth into three periods: (1) Early stage. (2) The second period might be considered to start at the time when the objective symptoms render the diagnosis rather obvious. (3) A third and final stage is that during which it is no longer curable by operation. It is impossible in any given case to say just at what time the growth merges from the second to the third stage—that is, at what moment a growth becomes inoperable—but when well advanced the third stage is easily recognizable.

(1) Early Clinical Characteristics of cancer of the mouth. The presence of some of these *may* make a diagnosis possible.

*Chronicity.*—The first of these is that the disease, having once started, rarely recedes. In the earlier stages its progress is not rapid,

and it may appear for months as an indolent sore. In this stage, the only suspicious thing about it is that, after removing the source of irritation, it does not yield to such simple remedies as appear to be indicated.

*Continuous Growth.*—The next thing noticed about carcinoma is that it not only does not recede, but is progressive. This extension is occasionally shown in the form of an external growth, but much more commonly by induration and ulceration. The base of a wart, the edge of a fissure, or the surface of an abrasion becomes hard, while a deep nodule becomes large. Any slowly extending induration in the mouth of a man, over 40 years of age, not due to some evident cause, should always excite grave suspicion.

*Induration.*—The induration is often of a hardness that is difficult to mistake for anything else. It is best detected by pinching up the suspected tissue between the finger and thumb.

*Ulceration.*—Another symptom of carcinoma, which may be the earliest objective sign, is ulceration. This is always surrounded by a wall of new growth in which the ulceration occurs, but it may be so limited in extent as to be not very evident. In other words, the growth may be continuously destroyed almost as rapidly as it forms, leaving only a thin layer of compact cancer substance between the floor of the ulcer and the apparently normal tissue. The ulceration may appear over a large surface before any induration can be felt.

*Pain.*—The next symptom in the order of diagnostic importance is pain. Pain may be a very early symptom and the first to attract the patient's attention. It may occur even before there are recognizable objective signs.

(2) Mid-period of Carcinoma of the Mouth.—At the beginning of this period some one or more symptoms will assume a more typical form. Later, owing to the progressive growth, ulceration and subsequent enlargement of the lymph nodes, pain, hemorrhage and distressing salivation are commonly added, while the peculiar general depression or intoxication, known as cachexia, is a thing that no cancer patient escapes unless the growth is removed before this has had time to develop. Besides this, a profuse discharge and a sickening odor are almost certain to hold a prominent place in the later picture.

*Growth.*—Sometimes growth continues in the form of an external tumor that may become very evident, even to protruding from the mouth, but this is very rare, and the later extension is usually only in the form of an induration that can be felt better than seen.

*Ulceration,* a constant symptom of oral carcinoma, due to a superficial disintegration of the ill-nourished cancer tissue, may appear before the induration is evident or not until the tumor has attained some size, but is usually a fairly early symptom. The ulceration may destroy the induration so rapidly as to be the most prominent feature. It may present a smooth, red surface that joins the mucous membrane in a sharp outline, or it may be covered with ragged sloughs or foul septic granulations. One prominent characteristic of the ulceration is that its edges are usually rolled and prominent, seldom "punched out," and almost never undermined. This is an important point in distinguishing between a carcinomatous ulcer and an ulcerating gumma.

*Pain.*—Pain as a rule develops early and is usually of an intense, persistent character, sometimes with a peculiar tendency to radiate, or be most pronounced in the top of the head or deep in the ear. Often the patient will be conscious of little or no pain in the growth, but will suffer torment at one of the sites mentioned.

*Hemorrhage and salivation* are rarely early symptoms. Pain may be intolerable, the salivation distressing, and hemorrhage of very frequent occurrence, the bleeding being often profuse but rarely directly fatal.

*Involvement of Lymph Nodes.*—In a general way, disease of the tip of the tongue or anterior part of the floor of the mouth will cause enlargement of the submental nodes. Disease of the body of the mandible and border of the tongue will affect the submaxillary nodes, but when situated farther back, the superior deep cervicals will be first invaded. These divisions of territory are not absolute in their anatomical arrangement, and when one set of lymphatics becomes diseased new channels through anastomosis are sought, so that eventually the spread of the disease is by devious routes.

When the disease is near the median line, then the lymphatics of both sides may be easily infected. In the later stages of the disease, the lymphatics of both sides are always infected, and the growth in the neck is often much more rapid than in the mouth (Fig. 158).

In the more advanced lymphatic infections the typical appearances of cancer will be evident. The nodes will be enlarged and more or less filled with hard, white tissue that may be cut like cartilage, and usually the glands will be seen to be adherent to neighboring tissue. Later, softening of the nodes or open ulceration will be found. In the neck carcinomatous ulcers are usually punched out or undermined.

*General Symptoms.*—As cancer of the mouth progresses, particularly if the tongue be involved, and especially if situated far back, difficulty of speaking and swallowing will develop. After any malignant growth has persisted for some time, it tells upon the general constitution and is evidenced by a feeling of malaise, loss of weight, and a peculiar yellowish color of the skin with the loss of all natural color. This is more pronounced in the later stages. With any advanced carcinoma of the mouth, the loss of weight and weakness are increased by the difficulty of taking food and the loss due to the

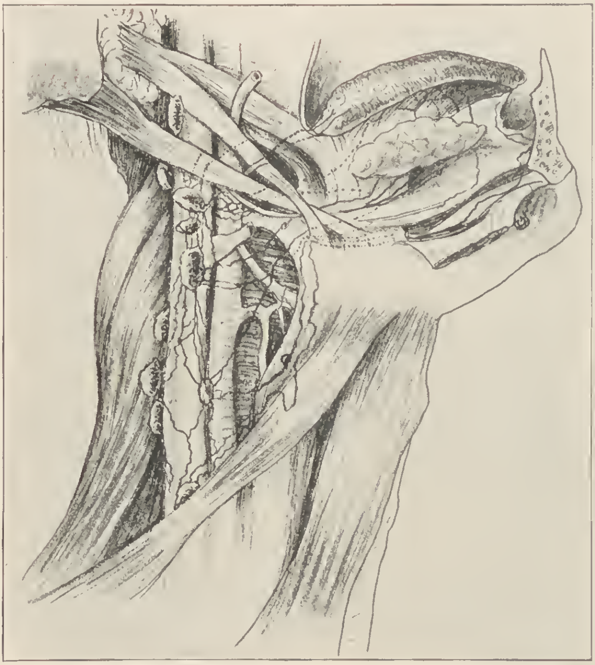


Fig. 158.—Lymphatics of the tongue.—After Poirer.

salivation. Late in the disease a foul discharge and worse odor are always present.

(3) Final Stage of Carcinoma of the Mouth.—In the last stage of the disease all of the symptoms mentioned as belonging to the mid-period are intensified. If the tongue is involved it may be fixed in the floor of the mouth so that it cannot be protruded. The lymphatic involvement in the neck may be very extensive. Some of the nodes first involved may have broken down, involving the skin and causing induration and discoloration or craterous ulcers. Before the skin is involved, the breaking down of the nodes themselves may be detected

by the softening or fluctuation present. The pain, salivation, cancerous discharge, and stench all unite to make this one of the most terrible of diseases. The patient, exhausted by lack of sleep and food, by sepsis, and by the toxins that seem essential to the disease, loses weight rapidly and before death comes is usually but a poor remnant of his former self. If the growth has involved the glottis, tracheotomy may have to be performed to prevent suffocation.

**Differential Diagnosis.**—Warty growths, simple ulcers and fissures, tuberculous ulcerations and infiltrations, primary and tertiary syphilitic lesions, and other granulomata may all bear a close resemblance to carcinoma. From our anxiety to make an early diagnosis, these resemblances may be annoying or misleading. There is never any real excuse for being seriously misled by a chancre. Its rapid growth and the early involvement of the lymph nodes should excite suspicion. The presence of the spirocheta is easily demonstrated, and if the patient is seen after the first few weeks, the secondary lesions will probably settle the question. Unbroken gumma or the ulcer remaining after the breaking-down of a gumma may present more serious difficulties. As described by Butlin, in their early stages an unbroken gumma and a deep carcinoma may have the following points in common: slow development; an ill-defined outline not separable from the surrounding normal tissues; both diseases prone to occur in the dorsum of the tongue, and in men over thirty. They may differ in the following points: gummata are often multiple; carcinomata rarely so. Intraoral tertiary syphilitic lesions rarely occur by themselves, there usually being marks of the disease in other parts of the body, but there is nothing to preclude a carcinoma from developing in a syphilitic or from an old syphilitic scar. The difficulty in distinguishing between the two may be so great as to be settled only by time, or a microscopical examination. Time spent in watching an early carcinoma is valuable time wasted, and if the diagnosis cannot be made, it should be treated as a carcinoma.

The diagnosis between tubercle and carcinoma is even more difficult. But primary tuberculous ulcers of the mouth are rare; and even when secondary ulcers closely simulate carcinoma, the presence of the primary lesions, usually in the respiratory passage and lungs, should suggest the probability of the same disease in the mouth. Even here, the conclusion cannot be certain, for tuberculous infection in the lung does not preclude carcinoma of the mouth. Here, again, the microscope can be a most helpful agent.

Between a simple papilloma and a carcinoma the diagnosis should be made by the microscope. The papilloma should always be re-

moved. If the wart arises in a patch of leucoplakia or chronic glossitis, it may be regarded as carcinoma. Between simple ulcers and carcinoma the diagnosis is often difficult. This is made more difficult by the knowledge that carcinoma can develop in a simple ulcer. The persistence or spreading of the ulcer and induration after removal of the apparent cause should be regarded as very suspicious.

**Differentiation between Operable and Non-operable Carcinomata.**—There are three factors to be taken into consideration in determining the operability of a case: the extent of the disease; the condition of the patient in reference to the probability of being able to withstand the effects of one or several extensive operations; and the experience and ability of the surgeon. If the local growth is confined to the tongue, it is always to be considered operable unless the tissues of the neck are involved well outside the lymph nodes. If it has involved the floor of the mouth on one side and even the jaw, or has extended to the wall of the pharynx or palate, the case may still be curable; but the risk from the operation is greatly increased, and the chances of success are small. If in a pharyngeal or faucial involvement the finger can be passed well beyond the posterior limit of a growth that is movable upon the deeper structures, its removal may still be undertaken with a faint hope of ultimate success.

**Treatment of Carcinoma of the Mouth.**—The method of eradication to be used depends to some extent upon the location of the growth, whether it is seen early or late, and its size. When the tongue and soft tissues alone are involved, the tumor should be excised with the knife. In cancer involving the surface of the jawbones, the older method of treatment consisted of some form of cauterization. Later this was condemned for the supposedly more efficient anatomical excision. Gilmer, later Bloodgood and others, have sounded a warning of conservatism in dealing with malignant tumors of the mouth, and within the past decade the pendulum has swung back to the use of the cautery iron. Now it is used at low heat as suggested indirectly by Percy and the cauterization is kept up for a long time, a sort of cooking process. Two hours is not infrequently consumed in cooking out a growth. Another popular method of removing the growth is by electro-coagulation with the high-frequency electric spark. The extent and depth of tissue destruction can probably be better controlled by this means than by the hot iron. If removal of the cervical lymphatics is indicated also, the neck dissection is usually done before the cauterization. Operative treatment should always be followed by intensive application of x-rays or radium or both to the

site of the original growth and to the adjacent lymphatic area. Seemingly inoperable cases are occasionally cured by the application of radium and x-rays alone. Cauterization, x-rays and radium treatment of carcinoma of the mouth are frequently followed by contracture of the jaws from formation of fibrous scar tissue, necrosis of the jawbones, and intense pain. These will require appropriate treatment. The pain can sometimes be controlled by deep alcohol injections of the branches of the trigeminal nerve.

The technic of operation on carcinomas of the mouth and various questions connected therewith will not be discussed.

**Odontomata.**—The *odontomas* comprise a large and important group of jaw tumors. An odontoma may be defined as a tumor derived from the special cells concerned in tooth development. Formerly, this term was applied to calcified masses alone, but it has been shown that uncalcified dental tissues can exist as tumors, and the cysts arising from cells concerned in tooth development are also included with odontomas.

Some very elaborate classifications of odontomas have been made to include all possible abnormalities. Below is a simple classification giving the commoner varieties:

1. Epithelial odontomas, where the abnormal development occurs in the dental epithelium alone:

(a) Multilocular cyst (Adamantinoma)
(b) Dentigerous cyst (Odontocele)
(c) Dental root cyst.

2. Composite odontoma, a calcified tumor, where the abnormal development takes place both in the dental epithelium, the dental papilla and sometimes in the dental follicle.

3. Connective tissue odontomas:

(a) Fibrous odontoma.
(b) Cementoma.

*Multilocular cyst* or adamantinoma (Figs. 159 and 160) is a benign tumor arising from the dental epithelium, usually with the formation of numerous cystic cavities, but sometimes consisting largely of solid tissue. The portion of the jaw involved is distended, containing a lobular mass, which projects from the alveolar border. The outer alveolar plate is usually more involved than the inner. In the maxilla, the maxillary sinus is nearly always involved. The thinned-out tissue over the cyst gives a peculiar elastic sensation when pressed upon. The growth contains numerous cavities filled with a viscid brownish

fluid. The cystic cavities vary much in size, and present a smooth lining with papillary projections which may partly fill the cavity. The septa between the cysts consist of fibrous tissue and sometimes bone. The cysts possess a lining of flattened or spheroidal epithelial cells, and columns of epithelial cells may be found in the fibrous stroma. Cells of a columnar character are seen which resemble the columnar cells of the enamel organ, while in other parts flattened cells akin to those of the stellate reticulum are found (Fig. 161).

These growths occur more frequently in the mandible than the maxilla and may be found at any age.

*Symptoms and Diagnosis.*—The patient complains of a swelling, usually in the molar region of the mandible, which has been very

Fig. 159.

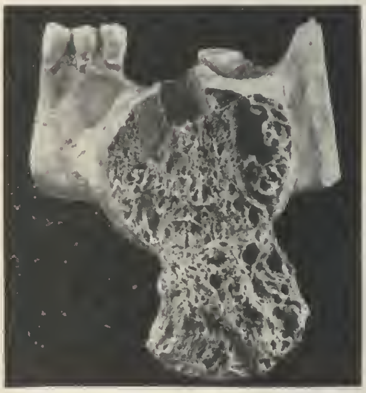


Fig. 160.

Fig. 159.—Cystic adamantinoma, from middle-aged man. Tumor had been present several years. (For one of the early descriptions of cystic tumors of the jaws, see British Med. Journ., Vol. 1, 1883, page 1.) (Hunterian Museum, London. Photographed for this book by courtesy of the curator.)

Fig. 160.—Multilocular cystic tumor, the septa being composed of fibrous tissue and bone. Probably of the same character as the preceding. Bland-Sutton would ascribe this tumor to endothelial origin. (Hunterian Museum, London. Photographed for this book by courtesy of the curator.)

slowly increasing in size. There is no pain. The alveolar border of the jaw is found to be enlarged, the outer alveolar plate being more affected than the inner one. When the tumor is larger it may possess a lobulated surface with thinning of the bone, and "parchment or celluloid crackling" can be obtained, or there will be an elastic sensation on pressure. If an opening into a cystic cavity exists, a fluid discharge is seen, usually viscid and of a brownish color. Infection may occur, obscuring the nature of the tumor. The diagnosis from inflammatory conditions and from other tumors and cysts can usually

Fig. 161.—Photomicrograph from cystic adamantinoma, showing cells resembling ameloblasts.

Fig. 162.—Multilocular cyst of anterior portion of mandible.

be completed by the x-ray picture (Fig. 162). There may or may not be a history of lack of eruption of a tooth.

*Treatment* consists in complete removal of the growth. It is very important to take away all of the tumor tissue or it will continue to grow and further operation will be necessary.

**Dentigerous cyst** or **odontocele** is a benign hollow tumor due to proliferation and degeneration of the cells of the enamel organ connected with an unerupted tooth, which is partially or completely developed, within the cyst (Fig. 163). The term follicular cyst, sometimes applied to these growths, is not so suitable as the other names, because the origin is not from the entire dental follicle, but only from the enamel organ. These cysts occur about the period of eruption,

Fig. 163.—Cystic tumor of the left side of the body of the lower jaw, containing a cuspid tooth. The cyst was lined with granulation. Probably of inflammatory origin. From patient, 13 years of age. One half of the jaw was excised, under the impression that it was a tumor. (See British Med. Journ. Vol. 1, 1864, page 241, and Injuries and Diseases of the Jaw—Heath, 2d Ed., page 165.) (Hunterian Museum, London. Photographed for this book by courtesy of the curator.)

nearly always in connection with permanent teeth, only four cases being recorded in connection with deciduous teeth. Any tooth may be involved, most commonly the canine, then the lower third molar. The mandibular premolars are more often affected than those in the maxilla.

The growth consists of a fibrous capsule lined with epithelium, filled with viscid straw colored fluid, and having a fully or partially developed tooth projecting into the cavity. The crown of the tooth is usually surrounded by the cystic cavity, and the root embedded in the neighboring bone, the capsule being attached to the neck of the tooth.

*Symptoms and Diagnosis.*—There is a gradually increased swelling of the jawbone, causing a bulging of the alveolar border. Later, the bone is thinned, giving the characteristic celluloid crackling. Fluctuation may be detected. The absence of a tooth from the series is a point of great significance. Suppuration may occur. The radiogram shows a clear area of bone destruction with well-defined margins, containing the unerupted tooth (Fig. 164).

*Treatment* consists in complete removal of the cyst with its capsule, and extraction of the tooth. An incision is made through the thin overlying bone, the cyst capsule is seized and gradually separated

Fig. 164.—Radiogram of dentigerous cyst of mandible, showing unerupted molar tooth.

from the wall of the bony cavity. Care must be taken not to leave a portion of the cyst wall around the attachment of the tooth, otherwise growth may continue.

*Dental root cysts* have been considered in connection with periapical infections (page 212). They arise as a result of irritation from the dental epithelial cell rests in the peridental membrane of a tooth that has undergone eruption, usually a pulpless tooth.

*A composite odontoma* is a calcified tooth tumor composed of a disordered conglomeration of enamel, dentine and cementum (Fig. 165). It may be erupted or unerupted. These tumors may be dis-

Fig. 165.—Composite odontoma, after Gilmer.

Fig. 166.—Swelling due to suppurating calcified composite odontoma, mistaken for osteomyelitis of mandible.

Fig. 167.—Radiogram of same case as Fig. 166 showing large composite odontoma of mandible, with unerupted molar beneath it.

covered at any age, and frequently are not recognized until the occurrence of suppuration, being then often mistaken for necrosis of the jaw (Fig. 166, 167, 168). Composite odontomas are found in either jaw, but more often in the lower, and generally in the molar region.

Fig. 168.—Odontoma after removal; weight 1½ oz.

Fig. 169.—Composite odontoma of mandible.

Frequently there is a normal unerupted tooth beneath the odontoma. An irregular swelling of the bone, that has existed for a long period and has very gradually increased in size, in the absence of a tooth, will suggest an odontoma. The radiogram will always reveal the

nature of the trouble (Fig. 169). If a sinus is present and a probe is passed, the hard, dense character of the tissue is felt to be quite distinct from bone.

*Treatment.*—The tumor should be removed, usually from within the mouth. It may be necessary to turn back the overlying gum and remove some of the bone, in order to dislodge the growth.

Fig. 170.—Cementoma in a girl, 16 years of age. Had been noticed for four years and gradually enlarging. Probably of inflammatory origin. A provisional diagnosis of odontoma was made, based on the fact that the tooth was not loose.

**Fibrous odontomas** consist of an overgrowth of the fibrous tissue of a tooth sac, and are very rare.

**Cementomas** are odontomas composed of cementum. They are to be distinguished from the hypercementosis due to chronic inflammation (Fig. 170).

## SUPERNUMERARY TEETH

Fig. 171.—Supernumerary teeth in a boy, 15 years of age.

The occurrence of supernumerary teeth is not uncommon. In most instances it is probably an atavistic recurrence of some tooth that has

been suppressed in the human—such as an incisor, premolar, or fourth molar. Such teeth are usually well-formed. Sometimes there is an ill-formed tooth that might have been developed from a "rest." Zukerkandl found enamelless tooth rudiments in the incisor region in twenty out of six hundred crania examined. Black and many others have observed instances in which there were additional buds given off from the dental strand. It is possible that, after giving off the normal number of buds, the dental strand may not always become absorbed, and it might go on producing tooth buds indefinitely. Such might be the explanation of those rare cases where an enormous number of denticles have been repeatedly removed from the same jaw. It is very rare that, where there are a number of supernumerary teeth, they are as well formed as in the case shown in Fig. 171.

## CHAPTER XXI

## CONGENITAL FACIAL CLEFTS, CLEFT PALATE AND HARELIP

The general relation of open facial clefts to the embryonal fissures has long been established; but there are certain points that are still the subject of discussion, and the cause or causes of their partial nonclosure are still to be determined.

### MORPHOLOGY

After the fifteenth day from conception, the cavity, from which will be formed the future mouth and nose, is bounded above by a tubercle projecting from the anterior part of the head, called the frontonasal process, and on each side by maxillary processes (Fig. 172). The mandibular processes join in the midline about the fifth fetal week, and they together form the lower jaw, which represents the first pair of visceral arches. The maxillary processes do not meet in the midline, but remain wedged between the frontal and the mandibular parts. The cavity is now bounded below by the mandible, laterally by the maxillary, and above by the frontal processes. About this time there appear on the lower end of the developing frontal process three tubercles, which are in turn called the central and two lateral processes. Each lateral tubercle is separated from the central by a short fissure called the lateral nasal groove, or olfactory pit (Fig. 173). Farther on the lower border of the central processes are developed two other tubercles which are called the globular processes, and these are separated from each other by a single central groove. From the frontonasal process with the nasal processes will be formed the forehead, external nose, and central part of the lip.

The maxillary processes are separated from the frontal, which now include the lateral nasal and globular processes, by the orbital fissure which extends to the mouth, in the upper part of which the eye is developed. Somewhere below its middle the orbital fissure is joined by the lateral nasal groove, and together they have been described by Merkel as a Y-shaped cleft.

The lower single limb of the Y opens into the mouth; while the external upper limb extends to the eye, and the upper median limb

is the lateral nasal groove which separates the lateral nasal from the central nasal process. The frontonasal and maxillary processes are separated from the lower jaw by a transverse fissure, the median part of which will be the future external mouth slit.

By the nonclosure of any part of the Y-shaped fissures, the transverse mouth fissures, or the cleft that existed in the midline between the mandibular processes, or the median groove between the globular processes are produced any and all of the typical face clefts which are here schematically illustrated by a slightly modified diagram from Merkel (Fig. 174).

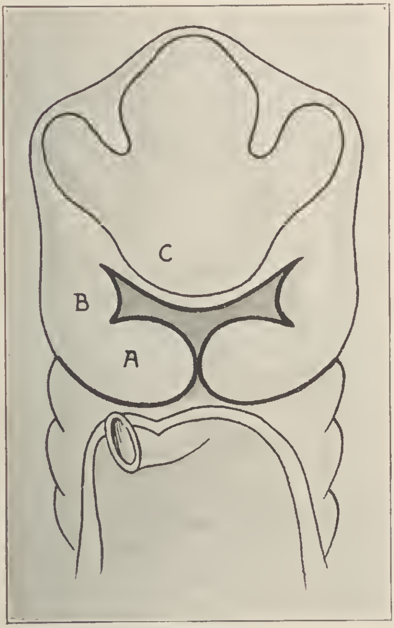



Fig. 172.

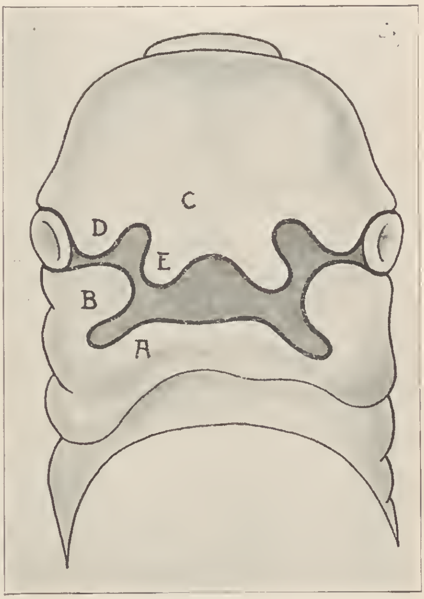



Fig. 173.

Fig. 172.—Head of fetus at end of fifth week (after His). C, frontonasal process; B, maxillary process; A, mandibular processes.

Fig. 173.—Head of fetus in the seventh week (after His). A, the now united mandibular processes; B, the maxillary process; C, frontonasal process; D, lateral nasal process; E, globular processes attached to the nasal part of the frontonasal process. The central nasal processes are separated from the lateral on each side by the lateral nasal grooves, which represent the anterior nares.

**Types of Clefts.**—If the maxillary fails to unite with the frontal process throughout the entire extent of the fissure, there will be a cleft extending from the mouth through the lateral part of the upper lip to the eye and possibly beyond: oblique facial cleft (Figs. 175 and 176). If the maxillary fails to unite to the globular process,

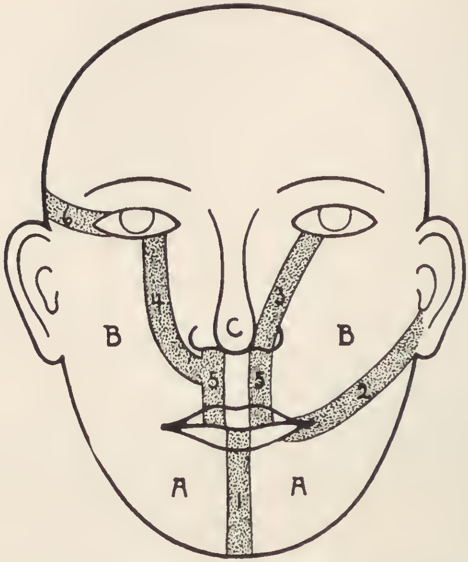



Fig. 174.—Schematic diagram, modified from Merkel, showing plan of facial clefts.

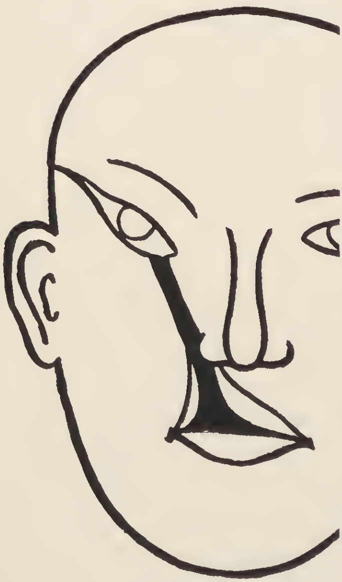


Fig. 175.

Fig. 176.

Fig. 175.—Diagram of oblique facial cleft. The cleft shown in this diagram corresponds to the cleft 5-4-6 in Merkel's diagram (Fig. 174).

Fig. 176.—Oblique facial cleft, complete into palpebral fissure on subject's left side.—From specimen in the London Hospital Museum, photographed for this book, by courtesy of the curator.

there will be a cleft extending through the lateral part of the lip toward or into the nostril: ordinary harelip (Figs. 177 and 178). If the two globular processes fail to unite with each other, there will be a median harelip which is usually only a notch (Figs. 179, 180, and 181). From failure of closure of the lateral parts of the transverse mouth cleft, an abnormally large mouth slit results: macrostomia (Figs. 182, 183, and 184). Finally, if the two mandibular processes fail to unite in the midline, a median cleft of the lower lip and possibly the jaw and tongue is the result (Fig. 185). The failure

Fig. 177.

Fig. 178.

Fig. 179.

Fig. 177.—Diagram of ordinary harelip.
Fig. 178.—Almost complete single harelip.
Fig. 179.—Diagram of median harelip.

of closure of any or all of the clefts may be so slight as to leave only a lip notch, or so complete as to involve the whole of the fissure, extending even into the base of the skull and brain, or to the ears or down to the sternum.

The palate is a part of the face. Its anterior portion as far back as the incisive fossa is formed by the frontonasal process. The maxillary processes through their palate ridges extend to the midline behind the frontonasal process and form the remainder (Fig. 186). The palate, therefore, is made up of three parts which were originally separated from each other by another Y-shaped fissure. The vertical

stem of this Y was posterior and lay between the two maxillary parts, while the two short oblique arms were anterior and separated the palate surface of the frontonasal process from the palate surface of

Fig. 180.—Median fissure of upper lip due to absence of the intermaxillary processes.—From specimen in the Royal College of Surgeons Museum, London, photographed for this book, by courtesy of the curator.

Fig. 181.—Skull from specimen shown in Fig. 180.—From a specimen in the Royal College of Surgeons Museum, London, photographed for this book, by courtesy of the curator.

the maxillary processes (Fig. 187). These and face fissures are but different views of the same through-and-through clefts.

If the whole of the Y-shaped palate fissure fails to close, there results a complete cleft which is double anteriorly, while partial failures

cause lesser clefts in various parts. These clefts will always be median behind the anterior palatine fossa and will be lateral in front of it, unless there has been a complete failure of union between the globular processes, in which case there might be a median anterior palate cleft corresponding to median cleft of the upper lip. Such clefts are re-

Fig. 182.

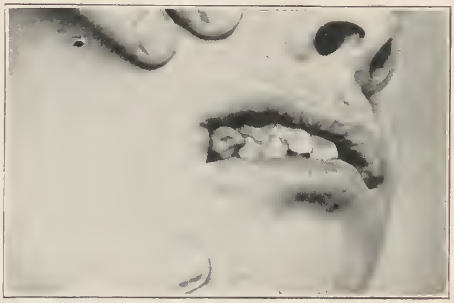


Fig. 183.

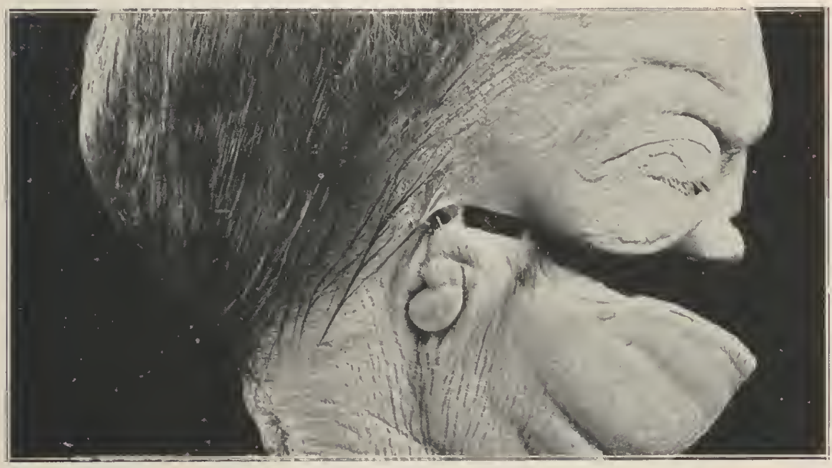


Fig. 184.

Fig. 182.—Diagram of macrostomia.
Fig. 183.—Macrostomia. Less degree than in the preceding.
Fig. 184.—Macrostomia. The oblong opening behind the mouth slit is from the removal of a piece of tissue for examination. (From specimen in the Royal College Museum, London, photographed for this book, by courtesy of the curator.)

ferred to by Lannelongue, Witzel and Brophy. This anterior median palate cleft is the rarest of all typical clefts.

The part of the palate that is derived from the frontal process is represented by the intermaxillary bones and their mucous covering.

Fig. 185.—Diagram of cleft of lower lip.

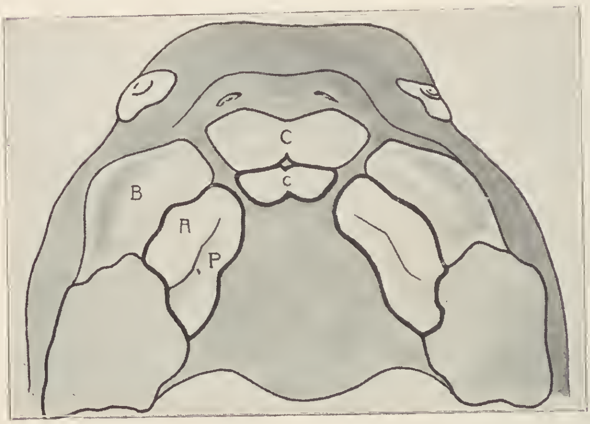



Fig. 186.—Diagrammatic reconstruction of the palate in the sixth fetal week. C, C, intermaxillary part of the palate and central part of the upper lip derived from the frontonasal process; B, lateral part of the lip; A, alveolar process; P, palate process; all derived from the maxillary process.

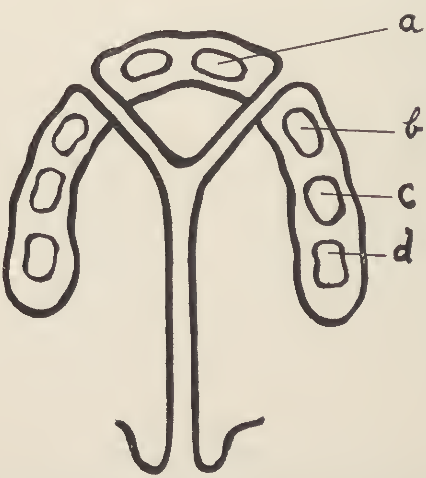



Fig. 187.—Diagram showing Y-shaped complete cleft of the palate: a, central incisor; b, canine; c, first molar; d, second molar.

These are continuous with the nasal septum which is derived from the same source. Later the septum joins the palate ridges when they meet in the midline, and thus the nose and mouth are separated into three cavities.

If the palate ridges fail to unite with each other, the nasal septum will also fail to unite with one or both of them, and through the resulting median cleft, the mouth cavity will communicate with one or both nasal fossæ accordingly. While embryologically the cleft is median behind the incisive fossa, it is often thrown to one side by the greater development of one palate ridge.

Closure of the palate fissures occurs first anteriorly and extends backward, the two halves of the velum being the last to unite. It is complete in the ninth week, and any agency that interferes with the closure must have acted before this time.

## RELATION OF THE ALVEOLAR CLEFT TO THE TEETH

The varying position of the cleft in the alveolus with regard to the incisor teeth has been a subject of interest and the cause of much discussion. In the majority of instances, the lateral incisor is missing,

Fig. 188A.—Case of complete double cleft in which at birth a tooth hung from the lateral margin of the alveolar cleft by a thin pedicle of soft tissue.

Fig. 188B.—Case of complete double cleft, in which tooth buds protruded from the outer border of the alveolar cleft on either side.

and the cleft lies between the central incisor and the canine tooth. There may be two incisors in front and a canine behind, or the cleft may extend between two incisors, or there may even be two incisors in front and a third incisor behind the cleft. Finally, there are re-

ported at least two instances in the human and one in a dog in which the cleft ran behind the canine.

## CLINICAL TYPES OF CONGENITAL CLEFTS

The deformity that is most commonly brought to the surgeon is complete single cleft of the lip and palate. If the cleft in the lip is double, it may be incomplete on one side (Fig. 190). If it is a complete double cleft of the lip, there will also almost always be a com-

Fig. 189.—This deformity is somewhat rare and has, in the past, not been fully understood; a midline cleft not being in conformity with known embryology. In this particular instance the deformity was due to the fact that the maxillae had united in the midline and the premaxilla and prolabium (the lower end of the frontonasal process) were above the maxillae attached to the nasal septum within the nasal fossae. There is an abundance of tissue present and, except for the permanent loss of the premaxilla, a good correction can be secured.

Fig. 190.—Double cleft of the lip, incomplete on one side. In this case the alveolar process was cleft only on one side, but posteriorly there was a double cleft of the hard palate. This is a not infrequent occurrence.

plete double cleft of the palate (Figs. 191, 174, and 176). Cleft palate may occur without a harelip, or more rarely a harelip occurs without any bony cleft; but it often accompanies a cleft limited to one side of the alveolus. Cleft of the velum alone is common enough, but cleft of the midpart of the palate with intact velum is very rare. Oblique facial clefts, macrostomia, and central clefts of the upper and lower lips or jaws are among the rare surgical curiosities. (See Fig. 189).

Fig. 191.—Complete double cleft of the lip. This is here accompanied by a double cleft of the palate. The intermaxillary bone carries three incisors.

## THEORIES OF FAILURE OF CLEFT CLOSURE

The exact reason for the failure of closure of the cleft has ever been a source of speculation.

**Heredity.**—The influence of heredity is very striking, but it has been difficult for us to compute its bearing with any exactitude in our cases. In a large number of the cases the lack of knowledge on the part of the parents precluded the possibility of getting data on the subject. In spite of this, the proportion of cases in which the defect can be traced through the immediate or collateral branches of the family is very large, and the instances are often very striking. It is not at all uncommon to find patent facial clefts in two children of the same family, and in one instance, we saw a mother and child both with cleft palate; and she informed us her father also had one, but she knew nothing of his progenitors. Heredity cannot be advanced as a cause, but simply as a transmission of a cause, and however interesting these observations may be, they shed little light on the etiology.

**Mechanical Cause.**—In speculating upon this subject, it seems fair to assume that the failure of closure of the clefts may be due to more than one determining factor, and in a study of the data at our disposal two possible causes stand out very prominently: (1) that some mechanical obstruction prevents the approximation of the cleft bor-

ders; (2) that some influence on the vital forces interferes with union after the borders are approximated.

The following may be included among the possible mechanical influences: Before the development of the palate ridges the tongue fills

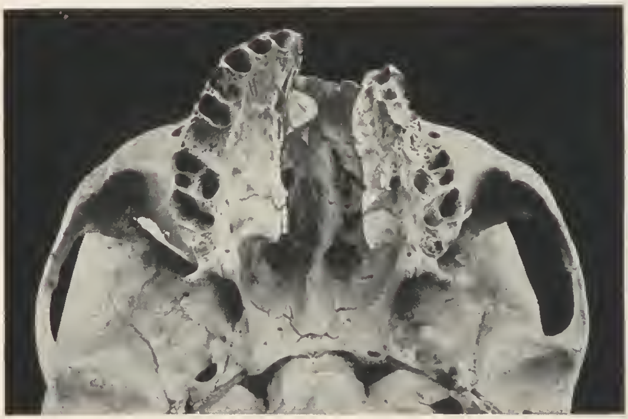


Fig. 192.—Skull of an adult who had a complete single cleft of the lip and palate. This deformity had never been corrected as shown by the lack of approximation of the alveoli at the anterior part of the cleft. (From a specimen in the Royal College of Surgeons Museum, London, photographed for this book, by courtesy of the curator.)

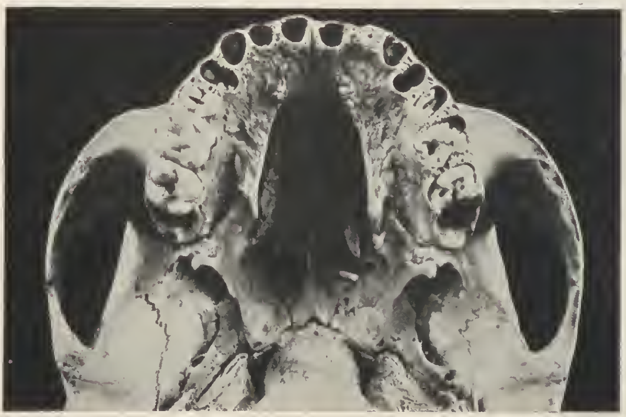


Fig. 193.—Skull of an adult who had a double cleft of the palate behind the incisive fossa. (From a specimen in the Royal College of Surgeons Museum, London, photographed for this book, by courtesy of the curator.)

the whole mouth and nose cavity, and its failure to recede from the nasal part has been ascribed by Tandler, Dursy, and others as a cause. One specimen of pig embryo has been observed that seems to support this view. In conjunction with this theory Friedrich states that the

tongue is still above the level of the palate in the second half of the second fetal month and that the cleft could be caused mechanically by the pressure of some underlying structure pressing upward on the mandible. In one case a left hand was tucked under the chin. In one case preserved in the Hunterian Museum in London, the tongue is adherent by a bond of tissue to the anterior end of the palate cleft.

**Tumors.**—Tumors must undoubtedly be the cause in some instances. Broca found a tumor of the base of the skull the cause of a complicated harelip, and Lannelongue found a tumor of the tongue accompanying a cleft of the palate. When of sufficient size and appearing early, tumors might cause very extensive clefts.

Amniotic bands and adhesions are so often associated with clefts and deformities as to leave little doubt as to their causative influence.

Fig. 194.—Incomplete cleft of the lip with a depressed groove running up to a spread nostril on that side.

**Maternal Impressions.**—The possible influences on the vital processes that could cause failure of cohesion of the cleft borders are probably numerous, but to be effective they must act before the time when the clefts normally close. One of the oldest theories in this regard is that of relation to maternal impressions. While it is unwise to absolutely deny the possibility of such a cause, still there is little material evidence to support this view. Our experience, like that of most other observers, has been that in every instance the supposed maternal impression occurred after the time of normal closure of the clefts.

**Malnutrition.**—Another supposedly possible influence, and one that cannot be so quickly disposed of, is malnutrition. It is a matter

of common observation that cleft palate and lip occur much more frequently among the lower and more ignorant classes, and apparently among those whose hygienic surroundings are poor. Among our cases, especially those occurring in families of the better classes, it has been a frequent observation that the mother, early in pregnancy, suffered excessively from nausea, or was in poor nervous condition.

**Injury and Infection.**—It is probable that both injury and disease may influence the closure of these clefts. While we are not as yet prepared to furnish anything like exact percentages, we have been impressed with the proportion of cleft palate patients that have shown signs suggestive of syphilis.

No explanation has ever been offered for the fact that palate and lip clefts appear on the left side twice as often as on the right. It is a common observation that lips and palates which are not actually cleft or which may be cleft in only a part of their extent may show a distinct line of irregular union that resembles a scar (Fig. 194). It may be accompanied by the broadening of the nostril and flattening of the ala that are typical of complete harelip. These are not true scars, for they show no scar tissue; nor do they ever contain mucous membrane with which all true lip clefts are edged.

## SURGICAL ANATOMY

The hard and soft palate together are collectively termed the palate, which is covered on both surfaces by mucous membrane and submucous tissue, etc. At the outer border of the hard palate, close to the alveolar process, and at the level of the posterior border of the last molar tooth is the opening of the posterior canal, through which the descending palatine artery and large palatine nerve emerge to enter the palate tissues. Other smaller palate nerves emerge from accessory foramina situated behind the opening of the posterior palatine canal (Fig. 7). Anteriorly, at the incisive foramen the nasopalatine nerve emerges with some terminal branches of the vessels of the nasal septum. In cases of double cleft palate, the distribution of these latter is confined to the intermaxillary bone. The maxillary tubercle is the prominence at the posterior end of the superior alveolar process. Behind and slightly internal to this tubercle can be felt the tip of the hamular process of the internal plate of the pterygoid process of the sphenoid bone. About 1 centimeter behind the hamular process the ascending palatine artery enters the velum subjacent to its oral mucous membrane.

The velum is intimately attached to the hard palate, not only by the palate aponeurosis, but by the continuity of its mucous coverings. Besides the azygos uvulae muscle, which occupies a median position, and portions of the palatoglossi and palatopharyngei, which form the anterior and posterior faucial pillars. the soft palate contains the terminations of the levator palati and tensor palati muscles. These latter, after arising from the base of the skull and skirting the lateral wall of the nasopharynx, enter the velum above the upper border of the superior constrictor muscle (Fig. 195). In the velum the contained muscles are intimately connected with the palate aponeurosis. The tensor palati descends between the external and internal pterygoid plates and is separated by the latter from the mucous lining of

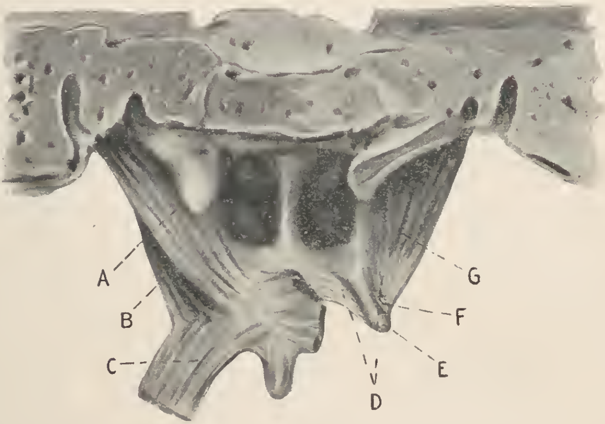



Fig. 195.—Palate muscles. Essential palate muscles viewed from behind. A, levator palati muscle; B, tensor palati muscle; C, palatoglossus muscle; D, tendon of the tensor palati muscle; E, hamular processes; F, bursa; G, tensor palati muscle.

the nasopharynx. At the apex of the internal pterygoid plate its tendon turns at a right angle over the hamular process, which serves it as a pulley, and then spreads out in the substance of the velum. Its motor nerve supply, which is from the fifth cranial, enters its posterior border and is well out of danger from cutting during a palate operation.

The levator palati muscle is situated behind the tensor, separated from the latter at its origin by the pharyngeal end of the Eustachian tube. As this muscle descends to enter the velum, it approaches the mesial plane and lies directly subjacent to the submucous tissue of the nasopharynx. Strange as it may seem, the motor nerve supply of the levator palati muscle is a matter of uncertainty. Most anatomists

believe that it is innervated by the eleventh cranial through the pharyngeal plexus, while Spalteholz, Merkel, and some others maintain that it comes from the fifth cranial through a branch that passes back from the large palatine nerve just after it enters the palate from the posterior palatine canal. This lack of exact knowledge is unfortunate, since the preservation of the nerve supply of these muscles conserves good functional success of the operation. Our own dissections and observations, made after various complicated palate operations, lead us to the belief that, with but few possible exceptions, operations for all cases can be so planned as to avoid injury to the nerve of this muscle, regardless of which course it really pursues.

The soft tissues covering the hard palate consist of the mucous membrane, the submucous tissue containing lymph follicles, blood vessels, and nerves, and the periosteum. These are all fused together

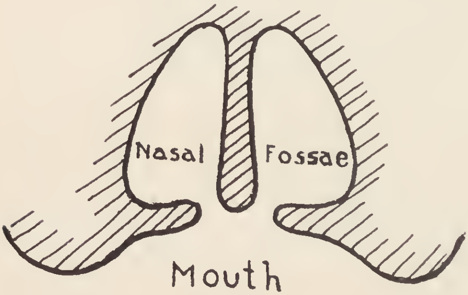



Fig. 196.

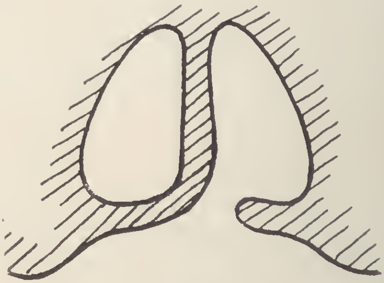


Fig. 197.

Fig. 196.—Diagram of coronal section through a double cleft of the palate
Fig. 197.—Diagram of a coronal section through a single cleft of the palate.

into a rather inseparable layer, but the whole is easily detached from the bone.

In front and laterally as far back as the maxillary tubercle, in the edentulous mouth, the soft tissues of the palate are continuous through the gums with the mucous lining of the vestibule. Where the teeth are in place, this continuity is carried on through the interdental portion of the gingivae.

In a double cleft, the mucous tissues of the roof of the mouth are continuous with those of the floor of the nose and nasopharynx on both sides, while the nasal septum, attached anteriorly to the intermaxillary process, stands free in the cleft (Fig. 196). The nasal and oral blood vessels anastomose freely around the borders of the cleft.

In a single complete cleft, the mucous membrane and submucous

tissues lining the roof of the mouth are continuous around one cleft border with the mucous membrane and submucous tissues on the upper surface of the palate process and velum, and at the other border with the mucous membrane and submucous tissues of the upper surface of the velum posteriorly, and of the lateral surface of the nasal septum anteriorly (Fig. 197).

## TREATMENT OF CONGENITAL CLEFTS OF THE PALATE AND LIP

**Age at Which to Operate.**—The general concensus of opinion at the present time is that the earlier in life these fissures are closed the better will be the results from the functional standpoint. While it is true that the cleft can be closed surgically in most cases no matter what the age, yet the nasopharynx, nasal cavities, and the tongue of one so afflicted develop abnormally, and where speech has been attempted with a cleft palate, the imperfect enunciation that results is but partially corrected by a late reconstruction of the roof of the mouth and the velum. This has caused operators to seek an early period for repair, and by a number the age of two years has been pronounced ideal for completion of the closure, because there is at this time a fair development of the mucoperiosteal covering of the bone with considerable arching of the palate due to the alveolar process, and because it is possible to narrow the cleft by orthodontic apparatus. Further, at this age the child's speech is but imperfectly developed, therefore the cleft palate speech habit is not fully formed, and successful operations at or before this age give excellent voice results.

**Brophy Operation.**—Brophy, on the theory that at birth all the structures are normally developed but that the two sides are separated by the width of the cleft, and that the longer growth goes on the farther these structures recede from the normal, recommends surgical interference in very early infancy, even during the first few days of life. The bones at this age being soft and pliable, he advocates bringing the two sides together by lateral compression until the cleft is obliterated as much as possible, and then maintaining this position by silver wires passed through the bone from side to side, the ends of the wires being twisted over lead plates moulded to the buccal surfaces of the jaw. Any remaining cleft at the posterior portion and also the fissure in the soft palate are closed at a subsequent operation.

Most operators do not do the complete Brophy operation, but are satisfied to close the extreme anterior portion of the cleft at the first operation, and then close the remainder by the ordinary flap operation at any time between the sixth and the twenty-fourth months.

Thus, in a complete single or double cleft palate, complicated by hare-lip, the following is the ordinary sequence of operations:

(1) From birth to three months—closure of cleft in alveolar process and lip. These are both done in one sitting if the vitality of the patient permits, or in two sittings if necessary.

(2) From six months to two years—closure of cleft in hard and soft palate, one or two sittings being required.

**Preparation for Operation.**—The healthy infant requires no preparation, and if old enough to take nourishment, should be fed within two hours of the operation.

Starved infants with a subnormal temperature should, by proper feeding, oil rubs, etc., be brought into relatively good condition. In dispensary practice it is a good custom to take such debilitated infants into the hospital for a few days until the child shows signs of mending, and then to send it home, keeping close supervision of its food and care. Usually ten days or two weeks is sufficient to bring the child to an operable condition. At least in summer, it is not wise to keep an infant in the hospital any longer than is necessary.

Special nipples, carrying broad obturators, have been devised to enable such infants to suck from a bottle, but when it is intended to do an early operation, these are unnecessary, as the infant can be more quickly and more accurately fed by means of an eye dropper. Some of them, with complete clefts of the lip and palate, can do very well with an ordinary nipple and bottle.

In the presence of any acute contagious disease, the operation should be postponed, but pus infections should be treated by appropriate surgical measures, general hygiene, and possibly by appropriate vaccines.

**Closure of Cleft in Alveolus and Lip.**—Cleft of the lip and cleft of the alveolar process are presented together, because the latter seldom occurs in the absence of the former and because, surgically, the closure of the alveolar process is related more intimately to closure of the lip cleft than to the palate cleft where the latter is present. The alveolar cleft and the lip cleft are usually repaired at the same time, from a few days to three months after birth. If at this period the protruding intermaxillary bone is put back into position and the lip closed over it, the lip pressure will keep the parts in normal posi-

tion, nasal breathing will be encouraged, and visible deformity, always objected to by parents, will be largely overcome.

Whether the alveolar cleft be single or double, the protruding intermaxillary bone is never to be removed, but is to be placed by digital pressure in the best attainable position, usually the cleft borders being denuded so that the raw surfaces will be in contact when the gap in the process is closed. In the case of double cleft, in order to allow the protruding intermaxillary bone to be moved backward it may be necessary to cut through the nasal septum just behind this bone (Fig. 198). Care must be exercised not to force the intermaxil-

Fig. 198.—Complete double cleft in an infant. White line shows where the mucous membrane is incised at the lower border in order to remove a V-shaped piece from the septum.

lary bone too far back or a flat upper lip will result. In single cleft the alveolar process should never be cut with a chisel, but in early infancy should be manipulated into as good position as possible by digital pressure and the immediate closure of the lip fissure relied upon to hold it there (Figs. 199 and 200). It is not necessary and often harmful to attempt to fix the intermaxillary process in position with a wire suture passed through the bone. This frequently causes serious injury to the undeveloped teeth.

After early infancy some orthodontic procedure may be necessary to draw together the borders of the alveolar cleft (Figs. 201 and 202).

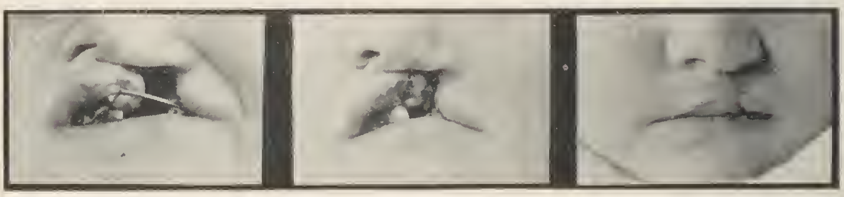
**Correction of Harelip.**—There have been so many various operations proposed for the repair of harelip that one seeking help from

Fig. 199.—Single complete cleft in an infant twenty hours old.

Fig. 200.—Same infant eight days later.

*A* *B* *C*

Fig. 201.—The first cast (*A*) shows a wide unrepaired cleft at the age of eighteen months. The cleft is partially filled by a transverse part of the nasal septum that would prevent the maxillary bones from being drawn together. At the first operation this transverse part of the nasal septum was removed and the palate repaired by a von Langenbeck operation. As a result of the traction of the soft tissues across the bony cleft the palate became narrower, shown in cast (*B*) made three months later, but there was still a wide alveolar separation. Dr. F. J. Brockman constructed the orthodontic appliance shown on cast (*B*), with which, by means of an elastic band, the alveolar cleft was closed in two weeks, as shown in cast (*C*). Then the lip repair was made.



*A* *B* *C*

Fig. 202.—Showing the obliteration of the alveolar cleft by means of an expansion arch by Brockman. Fig. 202*C* shows the final lip repair over the closed alveolar cleft.

the surgical text books is likely to be confounded by the wealth of ideas suggested. For the great majority of cases of single harelip,

either the Mirault or the Jalaguier operation gives satisfactory results. Only the general plan of these operations will be given here, and minute technical details will not be described.

**Mirault Operation.**—After undermining the lip so that it will slide over to its new position without tension, the edges of the fissure are prepared by incisions shown in Fig. 203. The mucous membrane is completely removed from the outer side of the cleft, while a small flap is made and turned down from the mesial side (Fig. 203-*C*). The raw edges are then united with sutures (Fig. 203-*D*).

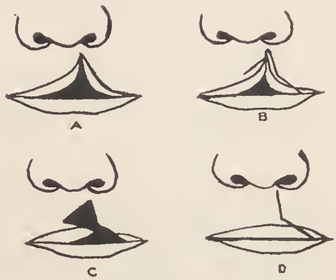


Fig. 203.—Mirault Operation.

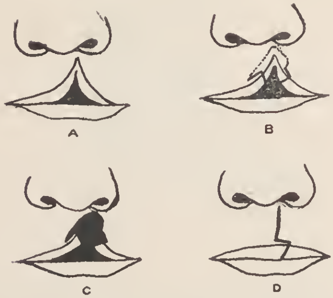


Fig. 204.—Jalaguier operation.

The **Jalaguier operation** is a modification of the foregoing, and is slightly more complicated. The various steps are shown in Fig. 204.

These operations, if properly done, give a natural looking lip of normal length, at the same time avoiding an unsightly notch at the lower border.

For *double* harelip the plan shown in Figs. 205 and 206 is simple and satisfactory.

**Correction of Deformity of the Nostril.**—In repairing a harelip, the restoration of the nostril and ala is usually the most difficult

part of the operation. Even in cases of slight lip notch there is usually some spreading of the nostril with a displacement of the columella, septum, and tip of the nose to the opposite side. The

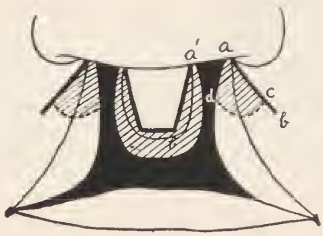



Fig. 205.

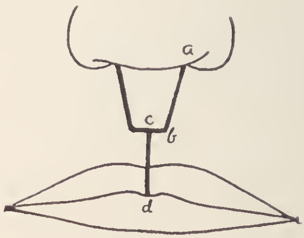



Fig. 206.

Fig. 205.—Operation we use for complete double harelip. The tissue within the cuts (c, d, a) is discarded on each side, as is the border of the prolabium.

Fig. 206.—Operation for complete double harelip completed.

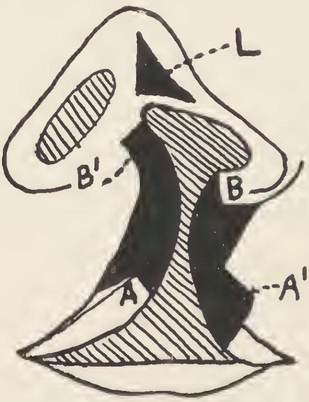



Fig. 207.—Ombrédanne's operation for correction of flattened nostril.

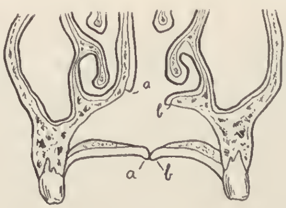



Fig. 208.—Diagram illustrating how the flaps taken from an incomplete palate arch together may be of sufficient width to reach across from one side of the base of the arch to the other.

normal shape of the nostril may be restored by thoroughly freeing the ala and bringing its lower edge over to the mesial side after making the incisions and denudations shown in Fig. 207 (Ombré-

danne). This operation is a combination of the Jalaguier operation on the lip with a procedure for correcting the flattened nostril.

**Closure of the Cleft in the Hard and Soft Palate.**—The cleft palate is an incomplete Gothic arch. When the mucoperiosteum on each side is incised at the borders of the cleft and the flap freed from the bone, which forms the sides of the incomplete arch, they can be brought straight across from one side of the base of the arch to the other (Fig. 208).

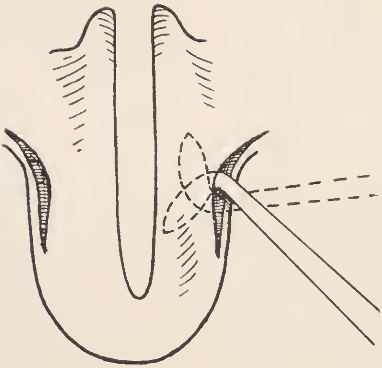


Fig. 209.—Freeing the flaps through lateral incisors.

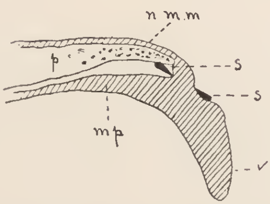



Fig. 210.—The blades (S, S) of a pair of curved-on-the-flat scissors in position to cut the palate aponeurosis and nasal mucous membrane from the posterior border of the bony palate; (mp) is the mucoperiosteum separated from the bony palate; (p) is the bony palate; (v) is the velum.

This is the principle employed in modern cleft palate operations, and is carried out with or without lateral incisions. In the operation usually employed, known as the Von Langenbeck, the mucoperiosteal flaps are freed through lateral incisions. The lateral incisions are made through the tissues of the hard palate down to the bone, each incision being close to and parallel with the molar teeth if present. If the teeth have not erupted, the incisions are made just mesial to the crest of the alveolar ridge. The mucoperiosteum on each side is then raised from the bone through the lateral incision

as far as the free median edge. In order to relax tension posteriorly, the mucous membrane covering the posterior surface of the soft palate must be cut free from its continuation into the floor of the nose. The free median borders of the hard and soft palate are fresh-

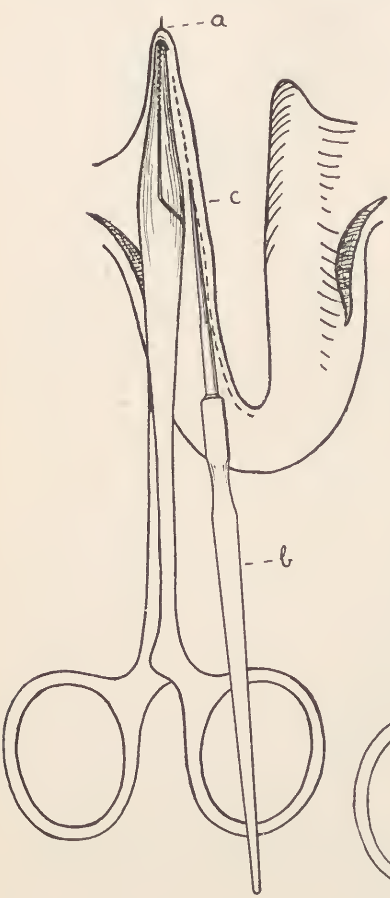



Fig. 211.


Fig. 212.

Fig. 211.—Prod and knife in position for denuding the left cleft border. In elevating the mucoperiosteal flaps from the hard palate, they are at the same time freed from their continuity with the nasal mucosa. Therefore it is unnecessary to extend the cuts anterior of the junction of the velum with the hard palate.

Fig. 212.—Knife and prod in position for paring the right cleft border. Ribbon of tissue is shown hanging from the left border of the cleft. If the border of the cleft in the hard palate has been freed with the elevator, the paring is done only in the velum.

ened and brought together with sutures. The various steps in this operation are shown in Figs. 209 to 216.

**Results.**—The later functional result will depend both upon the

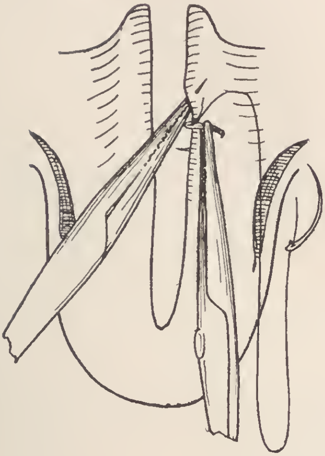


Fig. 213.

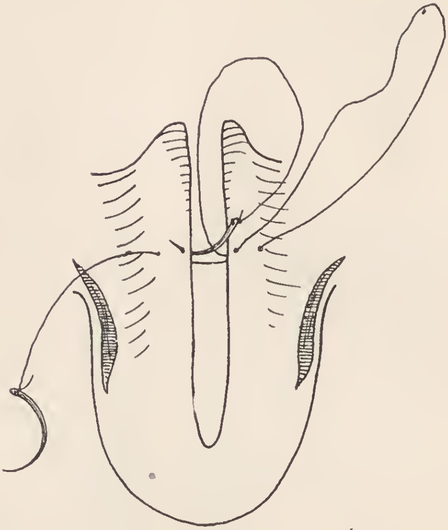


Fig. 214.

Fig. 213.—Shows first insertion of the needle at the junction of the hard and sofe palate.

Fig. 214.—Showing the last insertion of the needle for the superficial part of the vertical mattress suture. This suture has the advantage of approximating broad raw surfaces.

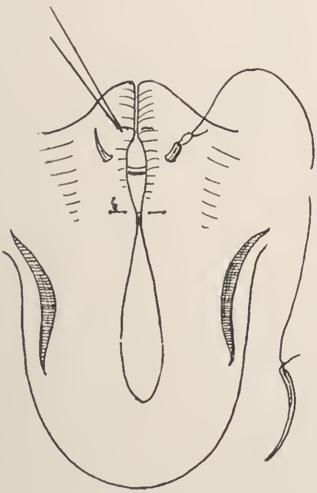


Fig. 215.

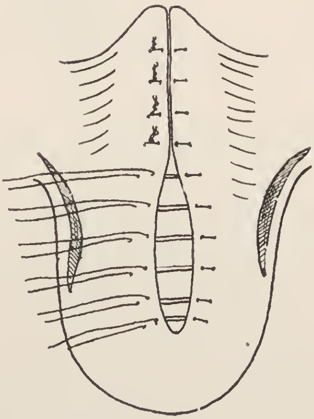


Fig. 216.

Fig. 215.—Each suture is used to make the velum tense while putting in the next suture.

Fig. 216.—The velum sutures are tightened before the sutures are placed in the mucoperiosteal flaps. The latter are all placed before any of them are tightened.

length and mobility of the velum and upon the ability of the patient to develop the use of the superior constrictor of the pharynx, and tongue, as aids of the velum, which latter after a late operation is always short.

As a general rule, the earlier the operation is performed the better will be the functional results. (See Speech Training, page 334.)

## OBTURATORS, ARTIFICIAL VELA, AND SPEECH TRAINING

In order to treat intelligently a cleft of the velum, either by operation or by the construction of an obturator, it is necessary to have at least a general idea of the physiological action of the muscles concerned, both in the normal and in the cleft palate.

**Physiological Action of the Muscle Concerned.**—The velum is a flap valve which, when raised by the levator palati muscles, helps

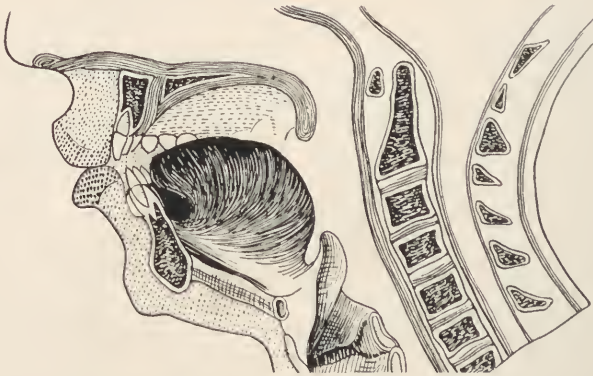


Fig. 217.—Position of the velum and Passavant's cushion in making the sounds *ah*. The velum and cushion close the opening also in making the sounds *oo, o, a, e, u, i, b, p, t, d, k, g, f, v, s, z, sh, zh, th, ch, j, l,* and *r*. (After Kingsley.)

to completely or partially close the nasal from the oral pharynx in order that the sounds emanating from the larynx may be modified in the mouth by the lips, cheeks, tongue, teeth, etc. (Fig. 217). A very few sounds known as nasals, such as *m, n,* and *ng,* do not require the closure of the nasopharynx (Fig. 218).*

This closure of the nasopharynx, which also occurs during deglutition, is not accomplished entirely by the velum, but partly by the posterior pharyngeal wall coming forward to meet the velum in the form of a definite protrusion, known as Passavant's cushion, which was

*For a clearly illustrated description of the mechanism of speech, see Kingsley's Oral Deformities.

first described by Passavant in 1868. This protrusion is due to the contraction of the upper part of the superior constrictor muscle of the pharynx, that part which arises from the pterygoid process, and is called the pterygopharyngeus. Röse has denied that the so-called "Passavant's cushion" is due to the action of the superior constrictor of the pharynx. Dr. Warnekros points out that, "such notable anatomists as Tourtual, Luschka, and Zukerkandl; such physiologists as Hermann, Landois, and Munk; such singers and laryngologists as Voltolini, Zaifal, Kingsley, Fränkel, Wendt, and Myer have in the past tested Passavant's observation very exhaustively and have rec-

Fig. 218.—Position of the velum in making the sound *m*. The opening into the nasopharynx also remains open in making the sounds *n*, *ng*. (After Kingsley.)


Fig. 219.—Diagram illustrating the contraction of the superior pharyngeal constrictor in the formation of Passavant's cushion.—After Warnekros.

ognized it as being thoroughly correct." We have seen cases where the action was very plainly visible. In Fig. 217, Kingsley illustrates the pad helping to close the nasopharynx, while in Fig. 218 the passage is shown to be open. The lower part of the superior constrictor muscle of the pharynx (Fig. 219) also takes part in narrowing the cavity of the oral pharynx. In Fig. 219 by K. Warnekros, *a* shows the outline of this part of the constrictor when at rest, while the dotted line *á* shews the outline of the muscle during contraction. When it is remembered that the palatopharyngei and the palatoglossi muscles lie within the circle of this muscle, it will be understood how it is that the contraction of this part of the superior

constrictor can narrow the width of a cleft in the velum during the effort of speaking.

The tensor palati muscles, as their name implies, by their action render the velum tense, but in the presence of a cleft their contraction causes the cleft to become wider. During normal nasal respiration the velum is held against the pharyngeal part of the tongue, mainly by the action of the palatoglossi muscles.

**Obturators and Artificial Vela.**—From this meager description it must be clear that operations for the correction of velum clefts must aim at producing a velum that is long enough to do its share in closing the nasopharynx; that in doing this the velum must be left sufficiently pliable to move freely in response to its various muscles;

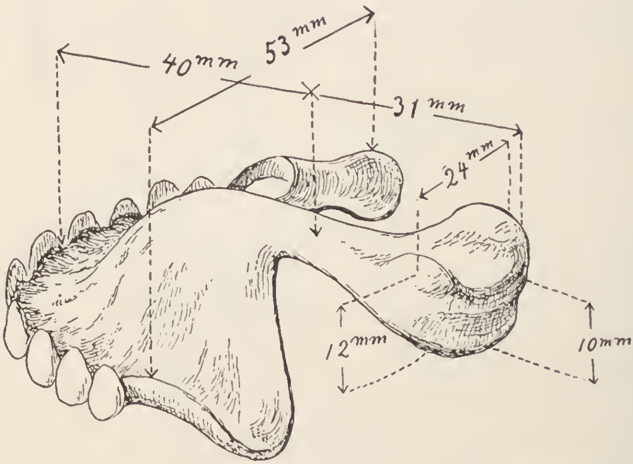



Fig. 220.—Obturator for a cleft palate.—After Warnekros.

and that these muscles must not be crippled or their nerve supply cut. It can also be understood how an inadequate velum can be supplemented by an obturator that closes the cleft and partially fills the space behind a short velum. For such an artificial velum or obturator to be effective, it is not necessary that it fill the entire passage between the nasal and the oral pharynx. It must occlude the space that is still left when the contraction of the superior constrictor muscles forms Passavant's cushion and constricts the transverse diameter of the pharynx and approximates the borders of the velum cleft.

Fig. 220 shows an obturator constructed by Warnekros for a patient with a cleft. Such obturators are usually made of vulcanite, but

the part filling the velum may be of flexible rubber. Once partially occlude the nasopharynx, and the diligent patient, by efforts at correct speech, will develop the actions of the muscles to the extent that later a smaller obturator is sufficient. Fig. 221 shows the obturator that was worn by this same patient subsequently.

Fig. 222, also from Warnekros, shows an obturator constructed to compensate for a short velum after operation. If there are teeth present, such obturators may be constructed to also occlude a cleft in the hard palate, but if all the teeth are absent, the presence of

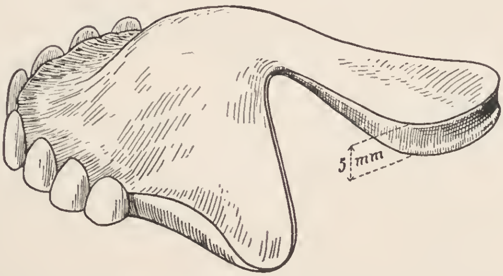



Fig. 221.—Obturator that replaced the obturator shown in the preceding figure after the palate and pharyngeal muscles had been trained. (After Warnekros.)

Fig. 222.—Obturator made to supplement a short velum. (After Warnekros.)

an anterior cleft renders the problem much more difficult. It has been our observation that under these circumstances obturators are of little benefit.

**"Cleft Palate" Speech.**—When a person has learned to speak with a cleft in the velum, even after the most perfect operation, there will remain the stigma of the "cleft palate" speech, which is due to the escape of air through the nasopharynx during the effort at producing sounds that require its closure. This is due to two causes: The cleft velum is shorter than the normal velum, and this defect is rarely remedied by operation; further, the patient who has

learned to speak with a cleft velum must be re-educated to the proper use of the newly constructed one. In some cases in the presence of a cleft, by diligent effort, the patient will develop the use of the superior constrictor muscle to an ultranormal degree. Such persons will give the best postoperative results, both on account of the muscular control that has been acquired and because the same determination that produced this control will be helpful in mastering the use of the new palate. This also applies to obturators.

Older children who have cleft palates are often found to be backward mentally, simply because they are ashamed to ask questions on account of the difficulty of speech, and because they have not the same incentive to study as children who are corrected and chided for their mistakes in recitations on account of their teachers not being able to understand them. Several schemes of postoperative speech training have been devised, among which is the teaching of a foreign language that has not been previously attempted by the pupil. A simple and rather effective plan, devised by Bigelow, is given below, and is the one we employ.

**Speech Training.**—Begin with the only consonant which a patient can usually best articulate, namely *t* in *tar,* and gradually lead to the rest, constantly referring to the acquired *t* as a point of departure. The great difficulty in pronouncing correctly with a cleft palate is in distinguishing the nasals from the mutes: thus *p-b* from *m; pap* or *bab* from *mam; t-d* from *n; tat* from *nan; k-g* (hard) from *ng*. *Tar* is well pronounced by most beginners with an obturator. When the beginner can pronounce *stark* and *car,* he has the key to most of what follows here. The above words should be practiced carefully and should be spoken loudly, or, as the elocutionists say, "exploded."

1. *tar artar kar arkgar kar*
2. *kar arkar arkgar kgar gar*
3. *kar arkar arkdar kdar dar*
4. *kar arkar arkpar kpar par*
5. *kar arkar arkbar kbar bar*
6. *kar arkar arklar klar lar*
7. *kar arkar arksar ksar sar*

Practice all the above with the following vowels:

8. *o* as in *coke.*

Thus, instead of *kar, akar, ko-oko-oklo-klo-lo.*

9. *a* long as in *cake.*

10. *i* as in *kite.*
11. *e* as in *keep.*
12. *u* as in *suit.*
13. *kar arkar arngar arkar arngar kar ngar bar mar*
14. *tar artar arnar artar arnar tar nar dar mar*
15. *par arpar armar arpar armar par mar sar rar*

Practice reading loudly from a book.

A patient, painstaking teacher and a docile, earnest pupil are two factors that go a long way toward success. If, after a thorough trial of this training, a good enunciation is not acquired, the surgeon may recommend an auxiliary obturator (Fig. 221).*

## OBTURATORS VERSUS OPERATION

The once rather spirited dispute between those who favored the use of obturators versus those who favored operative treatment of clefts is all but settled in favor of the latter. If any further argument were needed against the routine treatment by means of obturators, it could be found in the fact that Gutzmann, with his exceptional opportunities of observation on this point, has come to the conclusion that the operative results are the best.

Only in exceptional cases is the subject of operative risk to be taken into consideration in making a choice, although there is a certain risk in any operation, and the death rate from cleft palate operation *per se* is almost nil; and an open palate must more or less predispose to infections of the respiratory tract and middle ear. It is to be hoped that the knowledge of the immense advantage of the early operation will soon become so disseminated that before many years a child or an adult with an unoperated cleft will be as rare as are cases of large ovarian cysts today.

*We frequently recommend that these patients attend classes in a deaf-and-dumb school, or obtain the services of a teacher from such a school.

## CHAPTER XXII

# REPAIR OF ACQUIRED DEFECTS IN THE HARD AND SOFT TISSUES OF THE FACE

Defects in the soft tissues of the face and mouth are repaired by the sliding, or transplantation, of flaps of mucus- or skin-covered tissue, which are grafted into a new position. These flaps may be made from neighboring tissue, from tissue transplanted from some distant site, or even with tissue obtained from some other person. The latter procedure is almost entirely confined to the transplantation of pieces of skin or of the superficial layers of the skin.

In certain instances the defect is hidden by the use of some artificial structure that is made to resemble the missing part such as a wax or celluloid ear or nose. This art has been developed to a very high degree by Cruise, Hastings, and Wood, who use metallic masks to cover the missing parts, painted to resemble the lost surface tissues.

While this method is of value in elderly people or persons with marked defects who are unable to undergo severe surgical operations, in strong and healthy individuals, operative restoration of lost tissues of the face is as a rule far more satisfactory.

When the defect is of the bony structure, it may be repaired by the transplantation of bone or cartilage grafts, or by the interposition of some artificial structure such as an obturator in the upper jaw or a Martin splint in the lower jaw.

## VARIETIES OF GRAFTS

1. **Soft Tissue Grafts.**—Skin or mucous membrane and superficial fascia may be employed in the form of sliding or pedicled flaps, or the skin alone may be transplanted as free grafts as by the Thiersch and Wolfe methods.

*Sliding flaps* are formed by undermining the tissues in the neighborhood of the defect, mobilizing them so that they can be brought together to cover the gap.

*A pedicled flap* is made by cutting from the sound tissues an area of suitable size and shape to cover the defect, turning it into the defect, leaving a portion of the flap attached to its original site to

maintain its blood supply until healing takes place in the new situation.

*Fat or fascia lata grafts* may be employed advantageously in filling depressions in the soft tissues about the face. Transplanted fat from the patient's abdominal wall is usually employed.

2. **Bone** may be transplanted to fill defects in the jaw bones.

*Free bone transplants* are usually obtained from the ribs, tibia, or crest of ilium. The transplant is either placed directly in the defect (direct transplantation) or buried in the neighboring soft tissues until it gains attachment, and later moved into the defect by a sliding operation (mediate transplantation).

*Pedicled bone transplants* may be obtained from the neighboring portion of the jaw bone.

3. **Cartilage** is obtained in the form of free transplants from the 6th, 7th, and 8th costal cartilages and is used to replace lost portions of the nasal and malar bones, and the maxilla and mandible.

4. **Combined Bone and Soft Tissue** may be directly transplanted to the lower jaw region from the clavicle and tissues of the neck.

## TRANSPLANTATION OF SKIN- OR MUCUS-COVERED FLAPS

The surgical possibility of transplanting skin- or mucus-bearing flaps for the correction of tissue defects depends upon the following facts:

The skin and superficial fascia are redundant and elastic. The nutrition of a flap can be maintained through a relatively small pedicle, if it is accompanied by a layer of the subcutaneous fascia, and especially if this pedicle contains a distinct artery and vein. A flap of skin from which all subcutaneous tissue is removed, and which is not connected by a pedicle, is known as a Wolfe graft. Its life is much less certain than that of a flap that retains a blood supply, but it has this advantage: that it can be obtained from a distant site, such as the thigh. Grafts made of thin shavings from the epidermis are used to cover raw surfaces from which the skin is missing. These are known as Thiersch grafts. After a flap has united in a new position and a new blood supply is obtained, the pedicle can be cut without injury to its nutrition.

**Thiersch Grafts to Replace Lost Mucous Membrane of the Mouth.**—To correct certain deformities and contractures in which there is a loss of oral mucous membrane, Esser, Gillies, Waldron and others during the late war largely made use of free epidermic grafts to

epithelialize the raw surface in the mouth left after division of adhesions and removal of scar tissue. This method has some application in civil life, as injury or other cause sometimes produces adhesion of the cheek or lip tissue to the jawbone with obliteration of the buccal sulcus, rendering impossible the insertion of an artificial denture. The technic consists in thoroughly freeing the adherent tissues, somewhat overcorrecting the deformity, producing a cavity

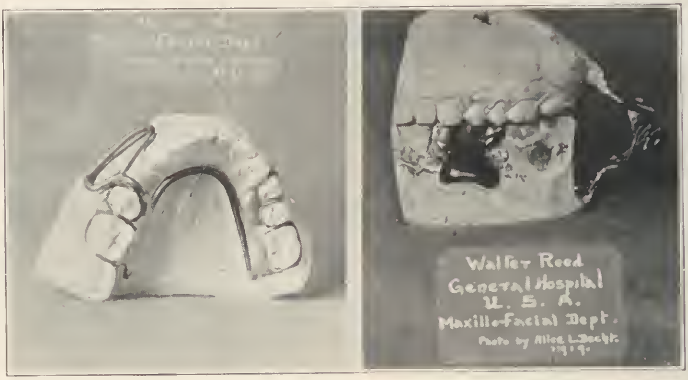



Fig. 223.—(*a*) Jackson spring-clasp appliance for retaining skin graft on modeling composition in mouth. (*b*) Permanent denture filling restored sulcus.

Fig. 224.—Restoration of sulcus with intraoral skin graft.

between the cheek or lip and the alveolar process. An accurate impression of the raw surfaces of this cavity is then made in modeling composition, which is allowed to harden. The piece of modeling composition is then removed, and the excess trimmed away. The compound is now replaced in the mouth, fastened to some form of easily removable yet firm splint, such as a Jackson spring-clasp appliance attached to the teeth (Fig. 223). The appliance and compound are again removed, and the compound is covered with a Thiersch graft,

wrapped smoothly over it with the raw surface of the graft out. The appliance is then inserted in the mouth, the compound serving to firmly maintain the skin-graft in contact with the raw surface of the buccal sulcus. After several days the appliance with the compound may be removed, and the skin will be found to be firmly adherent to the raw surface in the mouth, affording it an epithelial lining, replacing the lost mucous membrane (Fig. 224). To prevent re-contracture, it is important that the compound be immediately replaced with a permanent vulcanite piece, which may be part of an artificial denture (Fig. 223).

One of the most important factors for success in correction of defects of the soft tissues and bones of the face is the closest sort of cooperation between the surgeon and the dentist. Aside from the construction of fixative and supportive appliances, no one is better fitted than the dentist to handle the mouth sepsis arising from bone sequestra and dental lesions.

**Bone Grafts.**—In the ordinary mandibular fractures encountered in civil life, loss of substance with nonunion is rare, and it is seldom necessary to consider restoration of lost bone by transplantation. There are, however, two classes of pathological cases involving loss of substance of the lower jaw in which bone grafting should be considered as a reconstructive procedure. These two classes are: (1) Loss of a whole segment of the bone following osteomyelitis and necrosis. (2) Loss of a whole segment of the bone by an operation for removal of a tumor. In each case little or no attention usually is paid to maintaining the correct position of the lower jaw in relation to the upper. Consequently, when the diseased bone is removed, the ends of the two fragments are allowed to approach each other, either uniting or forming a loose fibrous connection with shortening of the mandibular arch, loss of substance and great visible deformity. Formerly, we were forced, in the attempt to improve the condition of these cases to resort to prosthetic appliances (such as the Martin splint) to replace the lost bone and hold the remaining portions of the lower jaw in somewhere near proper relation to the upper. These splints left much to be desired, as the patient never acquired sufficient stability of the jaw fragments to permit him to masticate solid food, and the apparatus required constant attention and readjustment. At the present time, for these cases, bone grafting may be resorted to for procuring the desired results.

In general, three methods of bone grafting have been shown to be satisfactory for replacing losses of substance of the mandible.

(1) Pedicled graft from the mandible itself as worked out by Cole. A piece of the lower border of the anterior fragment is removed, leaving attached to it a pedicle of digastric muscle and fascia below for nourishment. This is carried back to fill the gap and fastened to the fragments by means of silver wire. This form of graft is satisfactory in cases of loss of substance up to 3 cm. in the body or symphysis of the mandible. It is not applicable where the ascending ramus is involved. The pedicled graft is not so vulnerable to infection as the free bone graft, and union will as a rule take place more rapidly.

(2) Osteoperiosteal graft (Delagénière). A thin shaving of bone is removed from the antero-internal surface of the tibia, the overlying periosteum remaining attached to the graft. One piece of this is inserted into pockets beneath the mandibular fragments, between the bone and the soft tissues, and another in a similar manner over the fragments, with the bony surfaces of the grafts facing each other. The osteoperiosteal graft is flexible, easily adjustable to the size and shape of the lost substance, and contains all the elements necessary to osteogenesis.

(3) Thick graft from tibia, rib or crest of ilium. We prefer the crest of the ilium because it resembles the mandible closely in structure, is spongy and therefore easily penetrated with new vascular supply. The graft is inserted between and in contact with the mandibular fragments and fastened to them by means of silver wire or kangaroo tendon. This form of graft can be adapted to a small or a great loss of substance, and its bulk is advantageous from a cosmetic standpoint.

The preoperative treatment of all cases requiring bone grafting consists in removal of all sources of sepsis, reduction of the fragments, and fixation in such position that normal occlusion of the teeth is restored. Fixation may be attained by the use of some form of interdental splint, preferably one furnished with lock-pins permitting the jaws to be separated if necessary. In cases where the teeth and occlusion are good, wiring of the upper and lower teeth together will suffice for fixation.

The following is an example of a case of bone grafting:

A young man, twenty-seven years of age, when seven years old had a large portion of the mandible removed for sarcoma. He presented an absence of two and a half inches of the bone from the left side of the symphysis to the left angle, leaving a portion of the ascending ramus and coronoid and condyloid processes (Fig.

Fig. 225.—Radiogram showing loss of substance of mandible following operation for sarcoma.

Fig. 226.—Radiogram showing loss of substance of mandible replaced by graft from crest of ilium.

225). This fragment was freely movable at the joint. The remainder of the mandible was drawn considerably over to the left side, with consequent loss of facial balance and interference with function. The patient had worn a prosthetic appliance for a number of years, which enabled him to masticate imperfectly, but this had lost its fit. Splints were made by Dr. James E. Aiguier, fixing the right side of the mandible in proper relation with the upper jaw. On March 17, 1920, an incision was made over the region of lost substance, the ends of the mandibular fragments were exposed and freshened, and a graft two and a half inches long was removed from the crest of the left ilium and inserted to fill the gap (Fig. 226). Firm

Fig. 227.—Diagrammatic representation of the right costal cartilage from which cartilaginous grafts may be obtained.

union at both ends of the graft resulted, with great improvement in function and appearance of the patient.

**Cartilage Grafts.**—In reconstructive surgery of the bones of the head, and particularly of the jaws, we are indebted chiefly to Morestin, of Paris, for calling attention to the adaptability of costal cartilage in replacing lost bony tissues following war injuries. The 6th, 7th, and 8th costal cartilages are usually employed for this purpose (Fig. 227). Costal cartilage, unlike bone, can be readily trimmed or cut to any size or shape with a knife, while at the same time it is sufficiently resistant to take the place of bony tissue. The cartilaginous grafts readily attach themselves to the surrounding soft

tissues, though they will not unite with bone. Resorption does not take place, the original size of the graft being maintained indefinitely if perichondrium is transplanted with the cartilage. The removal of costal cartilages causes practically no inconvenience to the patient.

Fig. 228.—Receding appearance of chin due to loss of fatty tissue by operation.

Fig. 229.—Restoration of prominence of chin by costal cartilage transplant.

**Repair of Defects in the Upper Jaw.**—Costal cartilage may be employed for building out the face after loss of portions of the malar and maxillary bones following gunshot fractures of the upper jaw.

**Repair of Defects in the Lower Jaw.**—Cartilage is not adapted to filling in a breach of continuity of the lower jaw, because union will not be sufficiently firm to restore the function of mastication. For losses of substance of the mandible not involving its entire thickness, where external deformity is marked, transplanted costal cartilage proves very satisfactory in filling up defects. Figs. 228 and 229 illustrate the case of an officer who had the fatty tissue of the chin removed by an operation, which left him with a receding appearance. The prominence of the chin was restored by means of a suitably shaped piece of costal cartilage inserted beneath the skin.

## PERFORATIONS OF THE PALATE

When not due to gunshot injuries, perforations of the palate are nearly always syphilitic and may vary from linear defects, surrounded by absolutely normal tissue, to loss of most of the palate processes and all of their mucous coverings.

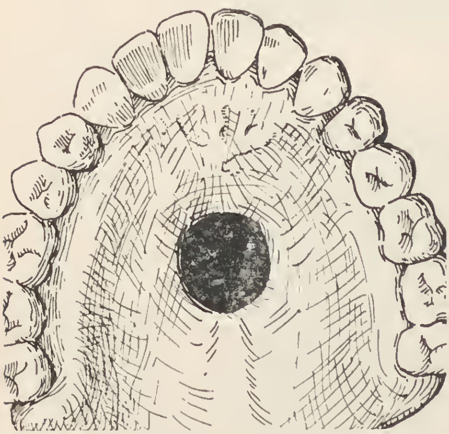


Fig. 230.

Fig. 231.

Fig. 230.—Diagram of defect in hard palate.

Fig. 231.—Restoration of defect shown in preceding figure, showing relative extent of the lateral incisions.

Small defects in the palate, up to the size of the end of a finger, are easily closed by making a lateral incision down to the bone on each side as close to the teeth as is possible without exposing the necks. The mucoperiosteal covering is raised, as in making flaps for repairing a congenital cleft. The edges of the defect are freshened and sutured together (Figs. 230, 231). If the palatine arteries

are uninjured and have been raised with the flap, the lateral incisions may be made to approach each other very closely in front. These perforations extend into the nose; the nasal discharge may be prevented from accumulating above the palate flap, and drainage is assured by passing a piece of rubber dam from the mouth through the lateral incision between the flap and the bone on each side.

For more extensive perforations some plan of flap transplantation will have to be adopted.

It has been recommended to treat small perforations by freshening the edges with the actual cautery and allowing the hole to close by granulations and scar contraction. For holes up to the size of a pea in the velum, this will be effective, but we have never had much success with it in the hard palate, even with the smallest openings.

Occasionally, after the creation of an opening through the alveolar process for intraoral drainage of the maxillary sinus, the opening refuses to close spontaneously. An opening of this character may be closed by a plastic operation, such as that recommended by Dunning. A palatal flap is taken, by making an incision extending from the median line at the junction of the hard and soft palates anteriorly to about opposite the premolar teeth. This flap is raised from the bone, and is nourished at its base by the anterior palatine artery. The outer edge of the flap is thoroughly freed, particularly around the edges of the opening to be closed, so that it can be brought right over the latter without any tension. The buccal tissues are now very thoroughly undermined and freed until a flap from this source can be brought to overlap or pass beneath the palatal flap. The overlapping flaps are then sutured. The essential for success here is to have broad overlapping surfaces without tension.

# CHAPTER XXIII

# MALOCCLUSION, IRREGULARITIES, DEFORMITIES OF THE JAWS

## MALRELATION OF THE DENTAL ARCHES AND OF THE JAWS

Moderate irregularity of the erupting teeth in front of the permanent molars is usually spontaneously corrected. But malrelations between the upper and lower first permanent molars, if untreated, are often followed by increasing malrelation of the jaws themselves. In some cases the malrelation of the teeth is the primary deformity, but we believe it may be, for a time, simply the first noticeable indication of disproportion in the bony arches. It is only later that the lack of proper intermeshing of the teeth becomes a factor in the continuously increasing deformity. We believe that atavism may be the primary factor in some cases. When the world was younger and the nations did not mix, very distinct facial types were developed and preserved. In the higher of these types the lower part of the face was proportionately small and protruded but little (Fig. 232). In others, less removed from the animal type, the jaws were the predominant features (Fig. 233). The present generation of white Americans is essentially a mixed race, and if we will grant that we can inherit different features from different ancestors, we think it must almost be granted that we can have jaws that are disproportionate in size. For instance, this is the only explanation that we can offer for the condition sometimes found in which the lower jaw is so large that the molar teeth have not been crowded forward into part of the space that was originally occupied by the deciduous molars, and permanent interdental spaces remain in the bicuspid regions (Fig. 234). We know of no growth in the length of the bone that can occur at this site. The skull illustrated in Fig. 235 shows what is possibly an atavistic retraction.

Disease or trauma may also be the factor that determines the overdevelopment or underdevelopment of either jaw. If from any cause there is a nasal obstruction which causes mouth-breathing, the upper molar teeth are deprived of the support of the tongue and the lower molars. In children this allows the cheeks to press the teeth, alveolar

processes, and maxillary bodies inward. As the upper jaw narrows, the height of the palate arch increases, the septum buckles, and the width of the nasal fossae is lessened. The original trouble might have been lack of development of the maxillae, adenoids, bony occlusion of the posterior nares, or any other obstruction. But no matter what,

Fig. 232.

Fig. 233.

Fig. 232.—Greek profile. (After Farrar.) Here we have a high forehead, continuous with a long, straight nose, a short upper lip, somewhat retreating, and a full curved chin.

Fig. 233.—Negro head showing prominence of the lower part of the face.

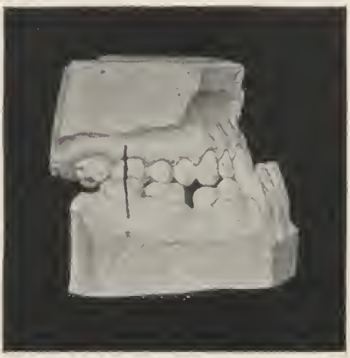


Fig. 234.—Protrusion of the lower jaw, due partly to interdental spaces in the bicuspid region. Part of the protrusion is due to a sliding forward of the body as a whole, as shown by the relation of the upper and lower molars.

the resulting mouth-breathing tends to still further lessen the size of the nasal passages.

The normal adult relation of the dental arches is not obtained until the bones are full-grown and the jaws are separated by a complete quota of teeth. An exception may possibly be made of

the third molars. The development of the face as a whole has an essential bearing on this relationship, for, as the maxillae grow downward, it changes the plane of the hard palate from above the temporomaxillary joint, as found in infancy, to a considerably lower level, best shown in an edentulous skull of age. The body of the mandible is carried to a still lower level by the interposition of the teeth and alveolar processes. The ramus of the lower jaw is formed to compensate for this change in position of the body. Until the ramus appears, there can be no real angle. Nontraumatic malrelations of the dental arches, or a portion of them, are as a rule early determined, and if not controlled, they increase with growth. As before mentioned, the teeth, properly apposed to each other in normal

Fig. 235.—Retraction of the lower jaw. Note that the deformity is due mostly to a shortening in the ramus, which is usually the case. In this skull, however, all of the vertical diameters—the height of the forehead, the height of the orbit, and the height of the ramus—are short in comparison with the transverse diameters, and the maxilla is prognathic. Yet, when considered alone, the prominence of the nasal bones and the shape of the cranium would place the skull very high in the scale of development. This we take to be a plain instance of atavism, and the malocclusion an accident dependent upon this atavism.

succession with concurrent growth of the bone, are the factors that establish the normal jaw. It is to faulty succession or position of the teeth and irregularities of bony development that most of these deformities of the bone are due. Atavism, trauma, or disease is the determining factor.

As in certain cases an abnormal angle is both a contributing cause and a result, a study of this angle and the factors which control it is opportune. During the period of complete permanent dentition

the angle of the jaw is, as a rule, about 100 degrees. In youth and extreme old age this angle is greater. From youth to adolescence these changes are accomplished by a deposition of bone, in old age by a process of absorption, although in childhood the bone may be bent in any part. At birth the body of the mandible is straight and rests squarely against the maxillae. From the cutting of the first incisors until the third molars are in occlusion, there is a space, posterior to the occluding teeth, which is an unsupported arch, upon which most of the power of the internal pterygoid and masseter muscles is expended (Fig. 236). The body of the lower jaw is not normally called upon unaided to resist the action of the masticatory muscles, nor is it capable of doing so. These, drawing on the angle,

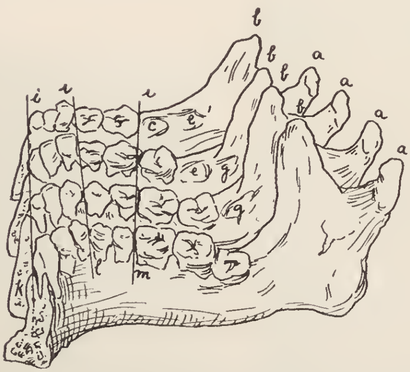


Fig. 236.—Diagram by John Hunter, illustrating the normal growth of the mandible. It will be seen that the bicuspid teeth occupy less space than did the deciduous molars which they replace. The extra space is used partly by the permanent canines and partly by the first permanent molar moving forward. If the teeth are not crowded into this space, bicuspid internal spaces may result. In the younger bones it will be seen that there is quite a space between the ramus and the last occluding tooth.

tend to cause a yielding upward in the body of the bone in the space between the teeth and the ramus.

**Protrusion of the Lower Jaw.**—The bending at the angle, when the body is unrestrained by proper interlocking of the teeth, allows the angle to open and the jaw to push forward. If, during this period, the inferior incisors are not firmly locked behind the superior, we have the beginning of a forward protrusion, which, if unresisted artificially, may result in the undershot jaw.

**Retraction of the Lower Jaw.**—The growth of the mandible is accomplished by the deposit of bone on the outer surface of the body and at the epiphysis of the condyle, and also on the posterior border and tip of the coronoid process and on the posterior border of the

ramus, with an accompanying absorption of their anterior borders, which brings about a backward march of the ramus (Fig. 236). If the lower jaw fails to develop in proportion to the upper, we have it, as a whole, retracted. Some observations have led us to believe that a short ramus is, at least partially, responsible for all cases of retraction of the body. Any early interference with the movement of the temporomandibular joint is always accompanied by a retraction of the lower jaw.

**Open Bite.**—We have already spoken of the yielding of the much-strained jaw body. There is a deformity, which appears to come from the yielding of an abnormally soft bony arch between the occlud-

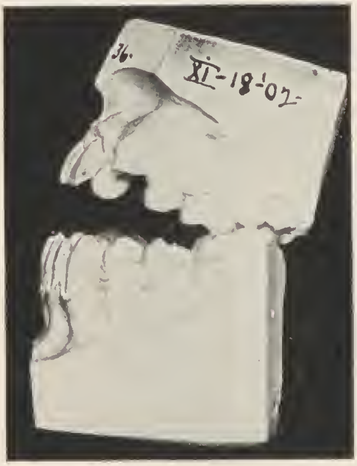



Fig. 237.

Fig. 238.

Fig. 237.—Open bite in a young white boy. It can be seen that the separation between the upper and lower incisors is due to the erupting first permanent molar. —Case of Dr. Lischer.

Fig. 238.—Open bite in a young negro boy showing rachitic malformation of the teeth. Second molars are in contact.

ing molars and the ramus, when the body is prevented from sliding forward by the upper incisors. The softened arch bows upward and then hardens, retaining this shape. When the teeth belonging to the bowed section attain full eruption, they are on a plane above the normal, and, occluding themselves, cause the open bite in the anterior portion of the jaw (Figs. 237 and 238). Although true as far as it goes, we believe this is probably but a partial explanation of the etiology. These are fairly common cases. All except one of the cases of this kind that we have observed have shown evidence of early rickets, which we think is the ordinary etiological factor.

In most of the cases we have observed, the open bite seemed to be due partly to a bending of the lower jaw in front of the second molar and partly to lack of development of the alveolar process on the anterior part of the upper jaw.

Fracture, malunion, or distortion of the jaw may cause open bite. Inability to close the mouth from lack of muscular force is a thing almost unheard of. After an excision of one Gasserian ganglion, or cutting of its posterior root, there is usually paralysis of the muscles of mastication of that side, due to cutting the motor root, but the muscles of the other side carry on function satisfactorily.

Contracting scars from burns on the neck and chin can greatly deform the developing jawbone.

## ORTHODONTIA IN THE TREATMENT OF MALRELATIONS OF THE JAWS

Before the twelfth or fourteenth year all of these conditions can be more or less perfectly corrected by orthodontic appliances; the success largely depending upon the age at which the treatment is begun—the earlier the better. As soon as any limitation of motion of the joint is noticed, systematic forced movements should be practiced. All children who have suffered injury of the joint or have had profuse suppuration in that neighborhood should be watched carefully. For even when the limitation finally results in a true ankylosis, it develops gradually and often goes unnoticed until the child is seen to be forcing food between the almost closed teeth.

The ability of the orthodontist to change the position of the teeth and the shape of the bones is dependent upon the same factors that permit of progressive malocclusions. In the growing bones abnormal pressure in any direction will cause a tooth to move its position. If this pressure is gentle and continuous, the alveolar bone will apparently move with it, being absorbed and redeposited to keep pace with the tooth. Some of the force is transmitted to the bones themselves, and in the very young the shape of the jawbones will be influenced by pressure applied to the crowns of the teeth.

## INDICATIONS FOR SURGICAL OPERATION

After the bones have hardened, or after bony ankylosis has occurred, appliances will accomplish nothing, and when the deformity is pronounced, these cases are legitimate and proper cases for surgical

interference. If the teeth are ever lost, it is impossible to make satisfactory artificial dentures for such mouths.

We have seen both disposition and nutrition radically influenced for good, and in the case of women, the resultant good cannot be overestimated. We would advise no one to undertake any cases without first having the fullest confidence of his patient, for during the convalescence trying complications might arise in which the surgeon will find his patience and his resources taxed to the limit. Operations on cases of moderate deformity should not be undertaken lightly, for the unforeseen accidents of surgery can here put the operator in a most unenviable position. It is real surgical work, although for its completion orthodontia is indispensable; and the earlier a competent, congenial orthodontist is associated in the case, the better it will be for both the surgeon and the patient.

## TREATMENT OF DEFORMITIES AND MALRELATIONS OF THE JAWS

### RETRACTION OF THE LOWER JAW

Maxillary prognathism without corresponding projection of the lower jaw is extremely common. When it is sufficiently pronounced to be a deformity, to correct it, we are not called upon to attempt to raise the profile to the standard set by the Greek sculptors, which would be a surgical impossibility. We may, however, bring forward the lower jaw to a harmonious outline, thus placing it within the limits of an accepted type, which is usually a possible procedure.

Artists have formulated laws of correct facial outline which should somewhat guide us in this work: (1) The septolabial angle should be ninety degrees. An exception to this is the case of the overhanging Roman nose, where it may be greater. (2) The lower lip should not protrude beyond the upper. (3) The distances between the hairline and the root of the nose, between the root of the nose and the subnasal angle, and between the latter and the tip of the chin should be about equal. None of these rules, however, are absolute.

**Correction by Traction.**—Before twelve or fourteen years moderate retraction of the mandible can be corrected by orthodontic appliances by gradually drawing the lower teeth and jaw forward until a new occlusion has been established (Figs. 239 and 240). This is apt to leave considerable obliquity of the chin, which, when pronounced, can be treated as described later (page 363).

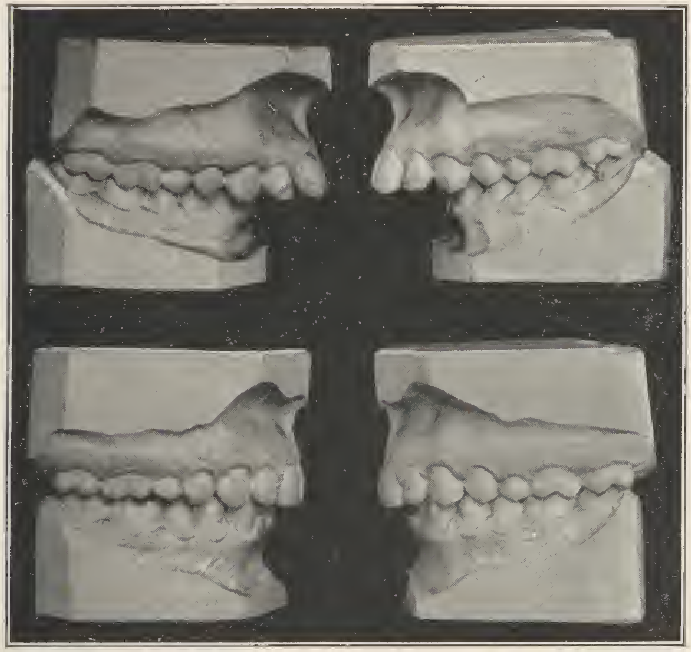


Fig. 239.—Retraction of the mandible corrected by orthodontic appliances.—(After Lischer.)

Fig. 240.—Retraction of the mandible corrected by orthodontic appliance. (After Lischer.)

**Correction by Surgical Operation.**—In operating, the surgeon must not attempt surgical impossibilities or be misled by false issues. Occlusion, normal or abnormal, is the result of pressure and counterpressure, of growth and apposition, and can never be established simply by bone-cuts. The real issues ordinarily at stake are facial outline (which includes both the profile and the lateral breadth) and the ultimate occlusion, while immediate occlusion is a secondary consideration. To do his work correctly, it is necessary that the surgeon shall have at least a theoretical knowledge of occlusion and of the scope and limitations of orthodontic operations.

In the operations to be described, we have to deal with an upper cubical jaw and a lower one that is a hoop of bone capable of almost any kind of adjustment; and it is upon the latter that our efforts must be expended. It must have occurred to almost every thinking observer that it would be easy to correct the open bites and underhung jaws if one could but cut through the bone that carried the nerve and blood supply to the teeth. The ultimate result of such a cut has been the cause of much contention among orthodontists for years. A fear of necrosis or nonunion of the fragments has held them in check, without reason, we think. Ununited fracture of the lower jaw is rare, and in the whole of the "Surgeon General's Index" there is not reported a single case, in English, German, or French literature, of necrosis or loss of teeth from sections of the vertical or horizontal ramus. Yet this is a recognized procedure for ankylosis. Esmarch recommends the removal of a section from the horizontal ramus for this trouble because of the liability of the bones reuniting after simple section. This is the method advised in the standard textbooks of today. We do not think that we need to concern ourselves with the consequences of cutting the inferior dental nerve and artery. Our experience, which covers quite a number of cases, bears out this conclusion.

In retraction of the lower jaw we have a condition in which the inferior dental arch, as a whole, bears an abnormal relation to the upper; and it is reasonable in correcting it to move it as a whole. This can be done best by making a cut through the vertical ramus. After the cut is made, the jaw is moved forward to the position desired. Occlusion and facial outline are both to be considered, and the jaw is to be steadied in place by inserting soft cement between the grinding surface of the teeth and fastening the lower to the upper with wires. Artificial fixation at the site of the cut is unnecessary. As to the location and direction of this cut, we have done

considerable investigating, but space will not allow us to do more than state our conclusions. This operation can be done above the entrance of the inferior dental nerve and vessels into the canal, thus avoiding their section. Here, however, one may be crowded for space and run the risk of injuring the parotid gland, large vessels, or the facial nerves. This section may be made in the line of the grinding surface of the inferior molars (or, preferably 5 millimeters above), with little risk of injuring any important structures except the inferior dental nerve and artery. In cutting the nerve where it enters the canal, which is at about this point, it has the best opportunity of reuniting.

## OPERATION FOR RETRACTION OF THE LOWER JAW

**Cutting the Bone.**—The operation is done in this manner: An incision 2 centimeters long is made through the skin over the posterior border of the mandible. The skin is drawn forward, and the parotid sheath is opened at the anterior border of the gland, which

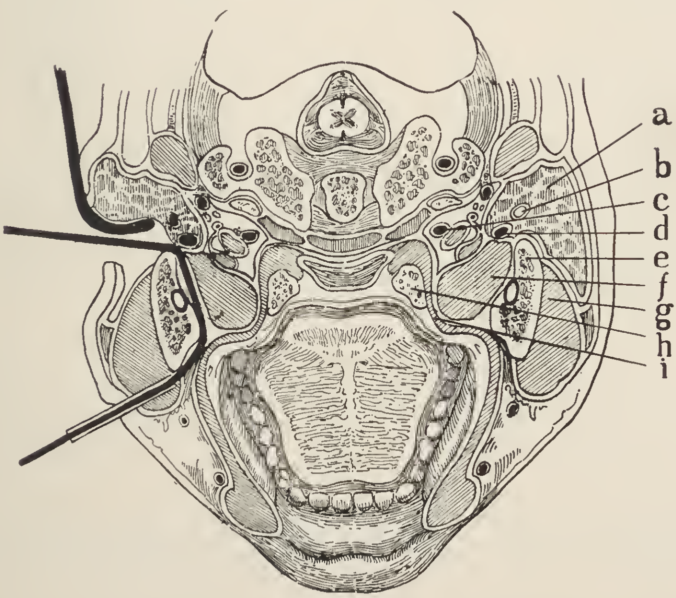



Fig. 241.—Transverse section of the face at the level of the occlusal surfaces of the molars. On the left is shown the wound through the skin and fascia. The parotid gland is drawn back with a retractor, and the wire saw is seen passing around the ramus and out through the cheek. Where it emerges, the skin of the cheek is protected by passing the saw through a thin metal tube. On the right side are indicated: *a*, parotid gland; *b*, temporomaxillary vein; *c*, internal carotid artery; *d*, external carotid artery; *e*, ramus of the jaw containing the inferior dental nerve and vessels; *f*, internal pterygoid muscle; *g*, masseter muscle; *h*, tonsil; *i*, wall of the pharynx.

latter is drawn backward until the posterior border of the ramus can be felt. A large, strong, curved needle on a handle, threaded with a heavy silk carrier, is now passed between the parotid gland and the masseter muscle behind the ramus, hugging the bone closely. It passes forward between the ramus and the internal pterygoid muscle and emerges through the cheek without penetrating the mucous lining of the mouth. The diameter of the curved part of the needle

Fig. 242

Fig. 244.

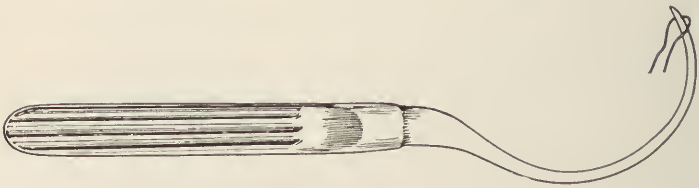


Fig. 243.

Fig. 242.—Subcutaneous section of the ramus. Showing points of entrance and exit of the wire saw.

Fig. 243.—Needle used for passing a carrier around the ramus of the jaw. It is important that the curve of the needle extends up to the point. If the point end of the needle is somewhat straight, the needle is very apt to pierce the buccal mucosa and enter the mouth.

Fig. 244.—Dilator used for stretching the muscles and also for stretching bands about the joint. It is made from a uterine dilator, in which the dilating prongs are shortened and then covered with 3 millimeters of solder. Great care must be exercised is using this instrument to avoid avulsion of the teeth or fracture of the jaw.

should be a little greater than the width of the ramus. It is followed by a Gigli wire saw with which the bone is cut through (Fig. 242).

Hemorrhage is controlled by packing the space with sterile or mildly antiseptic tape, which is left in place for two days. In this

operation the parotid gland is pushed out of the way, as is also the cervicofacial division of the facial nerve, which lies at the posterior border of the jaw. The temporomaxillary vein is also avoided, and the external carotid lies well out of the way. These anatomical points were verified by thirty special dissections (Figs. 241 and 242).

The needle used is full-curved. The curved portion, being almost one half of a circle of 4 centimeters in diameter, must extend to the point in order to round the anterior border of the ramus without penetrating the mucosa. The point is so formed that it will dissect the soft structures from the inner surface of the bone rather than

Fig. 245.—X-ray showing condition of the ramus some time after section. Notice the obliquity with which the part of the ramus above the saw cut meets the lower portion. Compare with Fig. 295, Chap. XXII, which shows the same ramus before section. In this case there was no operation performed on the ankylosed joint, and on that side there is only a fibrous union between the divided parts of the ramus. Later this union became so close that it was necessary to excise the ankylosed joint. The nail and wire at the chin were used to hold a piece of costal cartilage in place.

penetrate them (Fig. 243). In this way bleeding is avoided, and there will ordinarily be no danger of penetrating the mouth. To prevent damage of the skin, after the saw is in place, a short, small steel tube is passed over the anterior end of the saw, through the skin and down to the bone. Posteriorly, the parotid gland is held back with a small retractor. In cutting the bone, the saw is held as straight as possible, and the operator should be familiar with the peculiarities of the Gigli saw (Figs. 241 and 242).

This operation presents three distinct problems: (1) the cutting of the bone, which is the easiest of the three; (2) the placing of the jaw in its new position; and (3) holding it there.

**Adjusting the Bone.**—The posterior part of the occlusal plane of the molars inclines upward and backward. On account of this obliquity the body of the lower jaw can be brought forward only by lengthening the ramus; theoretically, the line of the saw-cut should be slightly downward and forward, about 5 millimeters lower in front than behind, so as to allow the body to be moved downward as well as forward without completely separating the several fragments. As a matter of fact, however, x-rays show that the fragments of the ramus remain in contact at the posterior border in the operations we

Fig. 246.

Fig. 247.

Fig. 246.—Showing deviation of the chin, which may occur with retraction of the jaw, due to limitation in motion.

Fig. 247.—Case shown in Fig. 246, after operation. The chin has been placed symmetrically.

have done, and it is very difficult to exactly gauge the positions and directions of the cuts.

It is only the posterior part of the body that moves downward, and the rotation thus produced lessens the obliquity of the plane of the chin, which is a very distinct advantage.

In order to lengthen the ramus, it is necessary to stretch the masseter and internal pterygoid muscles. This may be accomplished by inserting a fulcrum, such as a piece of pine, between the molars on each side and forcing the chin upward. (Another plan is the use of the dilator shown in Fig. 244). We have even found it necessary to use a one-half-inch piece of pine board, two inches wide and

eighteen inches long. The end of the board was placed back between the last molars, and a small piece of wood was placed transversely between the board and the upper biscupids, this latter being done to prevent injury to the incisor teeth. By means of this lever the muscles were cautiously stretched until the jaw could be brought forward. Even after this it may be necessary to grind or remove the posterior occluding molar teeth, and if this is necessary, it should be done at the time of the operation. As the bone is dragged forward, the saw-cuts gap in front, while the fragments remain in contact at the posterior border. This bone-gap must be filled with granulations. The resulting bone-scar tends to contract for months afterward, and unless permanent interlocking of the teeth is early established in the new position, some very hard-earned ground will be lost (Fig. 248).

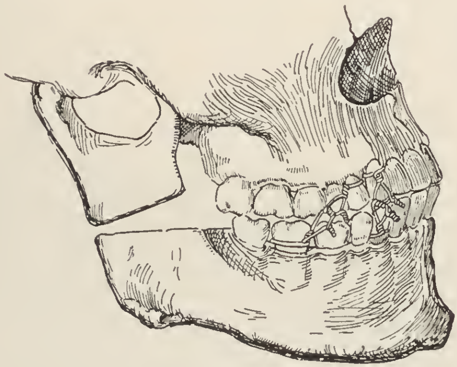


Fig. 248.—Showing jaw wired in its new position after section of the ramus.

In placing the body of the jaw, it is important that the chin is brought to the midline. Very often a retracted jaw deviates to one side, and in replacing it the general contour of the face is a better guide than the teeth (Figs. 246 and 247).

**Intraoral Fixation.**—As for means of fixation, we use the teeth, having never had satisfaction from any external adjuvant that we have tried. If the work is properly done, the teeth are sufficient. We have used all kinds of bands, but have found that the method of wiring the upper and lower teeth together, described under fractures (page 166), gives satisfactory fixation. To hold the jaw forward, the upper first or second premolar is wired to the last available molar in the lower jaw. This puts the pull in the right direction, and the strain is received on all of the molars in both jaws. To hold the

Fig. 249.

Fig. 250.

Fig. 249.—Showing obliquity of chin in retraction of the lower jaw.

Fig. 250.—Same patient as shown in Fig. 249, after bringing the jaw well forward. The obliquity of the chin is seen to persist, and something further will have to be done to render the result ideal. It was the result here shown that started the investigations that led to the transplantation of cartilage to correct chin obliquity.

Fig. 251.—Girl, twenty years of age. Complete bony ankylosis of left side, resulting from periarticular suppuration, following scarlatina at five years. Lower teeth had been removed to allow for a feeding space.

chin up, the lower canines or first premolars, are wired to the teeth directly above. Unless there are a number of interlocking points

Fig. 252.—Case shown in Fig. 251, after bringing body of the jaw forward and transplanting costal cartilage into chin.

Fig. 253.—Case shown in Fig. 251. Profile before operation.

of occlusion, quick-setting cement should be placed between the occlusal surfaces of the molars, for, if the wires are exclusively depended on, the retention will be painful and unsatisfactory (Fig. 248).

In operating, place the jaw well forward, disregarding the immediate occlusion unless it interferes with your ends; if it should, grind or remove the offending teeth. One of the most noticeable features of these cases is the obliquity of the chin. If we bring the incisors into occlusion, we have made use of only half of our opportunity; for, be-

Fig. 254.—Case shown in Fig. 251, after operations. The scar on cheek is from suppuration at the site of wound for cutting ramus. The dark spot under chin is wound through which the cartilage was inserted. Neither this nor the cheek wound had entirely healed at the time the photograph was taken. Later this scar became almost invisible.

sides the receding chin, there may or may not be an increased subnasal angle and an oblique chin (Figs. 249 and 250).

Retraction of the mandible may be due to early ankylosis of the joint, which it always seems to accompany. In this case we have found it advantageous to do the operation for ankylosis, described in Chap. XXIV, and at the same time bringing the jaw forward after cutting the ramus on the sound side. We have had to resort to the operation for ankylosis after bringing the jaw forward.

## OBLIQUITY OF THE CHIN

If, as will often be the case after an orthodontic or a bone-cutting operation for a receding jaw, the obliquity of the chin is so pronounced as to detract materially from the result, it may be improved by inserting a piece of cartilage or rib.

## PROTRUSION OF THE LOWER JAW

Protrusion of the lower jaw may be from overgrowth, from sliding forward, or from a combination of these.

The lower jaw may protrude a considerable distance beyond the upper. When the protrusion is marked, especially if there are interdental spaces in the bicuspid region, the lingual inclination of the incisors is extreme (Fig. 234). This is due to the pressure of the orbicularis oris muscle.

**Correction by Traction.**—To correct this condition, different means must be adopted. If seen early, before the twelfth year, in many cases the jaw can be forced back to its proper position by a chin and head cap connected by elastics and worn for several hours each day, after the plan suggested by Angle. That this will be successful in every case, we are not sure. If seen after the bone growth is completed, a different means of correction must be adopted, which is the removal of a piece of the jawbone on either side (Figs. 255 to 257).

**Correction by Surgical Operation.**—Where the lower jaw as a whole occupies a forward position, there will be also lateral protrusion, for two reasons: (1) The broader posterior part of the lower jaw is brought opposite the narrow anterior portion of the upper; and (2) when this occurs, the impact of the jaw is taken, not on the buccal cusps of the lower molars, as is normal, but on a part nearer the lingual cusps. This tends to rotate the lower molars lingually, which is accompanied by an outward rotation of the lower border of the bone. Thus we have a real spreading at the lower part of the body. This lateral protrusion must also be corrected or compensation made.

Sections of bone of the proper size are removed, and the fragments brought together. The cuts are illustrated in Figs. 260 and 261 by the lines (aa). The sections (dd) are removed, then the fragments (cbc), shown in dotted lines, are moved in and back to form the new arch (c′, b′, c′). The lateral fragments rotate on an axis corre-

sponding, not to the last molar tooth, but to the temporomandibular articulation (oy). Now, as the distance from the cut to the last molar (xx) is about one-half that from the cut to the axis of rotation (xy), the anterior end of the fragment will move in twice as far as does the last molar, which is about in proportion to the usual dis-

Fig. 255.

Fig. 256.

Fig. 255.—Protrusion of lower jaw in man 27 years of age. Lower jaw is abnormally large, and upper jaw abnormally small. When the mouth closed, no tooth in the lower jaw touched any tooth in the upper jaw.

Fig. 256.—Same case as shown in the preceding figure.

Fig. 257.—Case shown in the preceding two figures after operation. On the right side a section of the jaw-bone was excised behind the first molar tooth.

placement of the two points. By this operation both the lateral and the forward protrusions are corrected.

In determining the location of the cuts and their directions, plaster models and x-ray should be used. Still, here, as everywhere else, the eye and the finger of the operator must be the surgeon's most useful guides and instruments of precision. While one can bring forward a retreating chin with every assurance of improving the facial

Fig. 258.—Protrusion of the lower jaw. Correction by orthodontic appliance.—After Lischer.

Fig. 259.—Protrusion of the lower jaw corrected by orthodontic appliance.—After Lischer.

outline, in setting back a protruding chin so that the lower incisors will be in normal occlusion with the upper, one might destroy the one strong feature in an otherwise weak face.

Often protrusion of the lower jaw is accompanied by an abnormally small upper jaw; therefore the chin should be brought back only far enough to be in harmony with the other features, leaving it to the orthodontist to bring forward the upper incisors if necessary, but the orthodontist should be in consultation in the case from the first. Indeed, in some cases it would be of considerable advantage to have the upper jaw expanded and the upper incisors and canines brought forward before the operation on the lower jaw.

The contraction of the upper jaw is probably due to the fact that

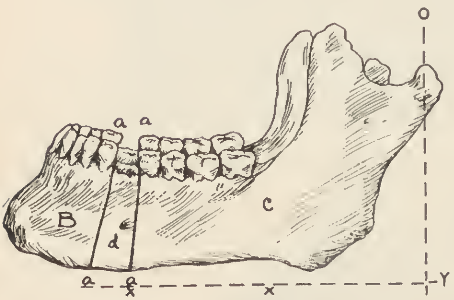



Fig. 260.

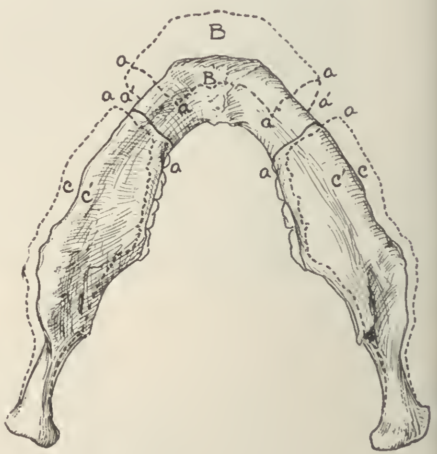



Fig. 261.

Fig. 260.—Abnormally long jaw with interdental spaces in the bicuspid region. Showing position of cuts for correction.

Fig. 261.—Reconstructed jaw, showing how both forward and lateral protrusions are corrected by removing bone sections. The dotted lines indicate the jawbone shown in the preceding figure.

the tongue finds an abnormal amount of room within the lower dental arch, which allows the upper arch to contract or fail of full development. If the size of the lower arch is suddenly contracted, the tongue will be deprived of some of its accustomed intraoral space and must be forced back into the oral pharynx. We have never seen more than a temporary respiratory embarrassment from this, but it is a point to be borne in mind.

In operating for protrusion of the lower jaw, the bone may be cut in the ramus or the body. In first considering this operation, we dismissed the ramus for the reason that in the case in hand much of the

protrusion was due to overgrowth of the body, and we feared that, if we cut the ramus and forced the body back, the space behind the angle might be crowded when the mouth was opened.

Dr. W. Wayne Babcock, of Philadelphia, reports two cases which he corrected by operation upon the ramus. From the illustrations, however, we believe that in his cases the deformity was due wholly to a sliding forward of the body and not to an overgrowth of the bone. If our conception of the pathology is correct, it is perfectly reasonable to correct such cases by sliding the body back into place. Dr. Babcock was led to adopt this procedure for fear that, if the anterior attachment of the tongue was moved back, there might be respiratory embarrassment; for, if this followed the operation on the ramus, it could be corrected by drawing the jaw forward.

In operating upon the body, the bone may be cut submucously without extending the incision into the mouth, in which case the wound should remain sterile. The open operation, in which the bone and its coverings are sawed through right into the mouth, is not fraught with the dangers that some commentators on this operation have conjured up. It is a fact, known to all of any clinical experience, that nearly all fractures of the body of the jawbone are open fractures and that, unless there is splintering or comminution, these open fractures unite about as quickly as do closed fractures. Even when there is considerable suppuration, healing and union usually follow quickly after inferior drainage is established and the pieces of dead bone are removed.

While the subperiosteal operation has much to commend it, not all of the points are in its favor. The sawing can be more accurately done with a straight than with a wire saw, and none of the remaining bone is deprived of its periosteum. Should there, during the subperiosteal operation, be established through accident a communication between the wound and the mouth, necrosis of the bone might occur; a thing most improbable when the periosteum is left intact on the remaining bone and free drainage is provided.

As before stated, the site of the bone-cuts, the size and shape of the sections to be removed, and the means of retaining the newly constructed jaw are determined before the operation. We think the site of election is at the second bicuspids, but one may be deterred from sacrificing these teeth by the presence of other natural or acquired interdental spaces. We once removed a section at the site of a missing second molar on one side. If the submucous operation is to be done,

the teeth are to be removed at least four weeks before the operation, but if it is to be an open operation, the teeth may be removed at the same time. In operating on the ramus, no teeth need to be removed.

**Adjusting the Bone.**—The bone sections having been removed, the new arch is formed by wiring the remaining fragments with silver wire, which was put through the holes drilled before the saw-cuts were made. The final twisting of these wires is not done until the intraoral fixation is made.

**Intraoral Fixation.**—The means of splinting the fragments is important. Hullihen, in 1850, for a case in which he had resected and replaced the alveolus, devised a continuous metal splint cemented over all the teeth in the lower jaw (Fig. 57). We first tried wiring the bones, and also the lower jaw to the upper. In commenting on a case of this kind on which we had operated, Dr. Angle suggested a metal

Fig. 262.

Fig. 263.

Fig. 262. —Lateral view of Angle splint, showing flanges drilled for bolts, and also bicuspid teeth that were removed at operation.

Fig. 263.—Angle splint after operation, lateral view. To allow for inaccuracies, the distance between the flanges was made larger than the section of bone to be removed. After operation the space between the plates was filled with a piece of lead plate, beaten and cut to the proper shape.

splint made in three sections, which is to be cemented over the teeth before the operation. The portions of each side to be removed were not to be covered by the splint, and the adjacent ends of the splint were to serve as guides in the sawing. When the bone is removed, the ends of the three pieces of splint are fastened together. We have not found it practical to make the splint serve as a saw guide, but Figs. 262 and 263 show a modification of Angle's idea, made for us by Dr. J. A. Brown, which worked satisfactorily. The use of such a splint allows the mouth to open. We would not dispense with the

lower fixation in this operation. Proper fixation here consists of fastening the cut bones with silver wire or with chromicized catgut at their lower borders, and for the upper fixation using the Angle splint, or wire. In wiring, the teeth adjacent to the cuts should not be used. It will be much better to have bands, carrying rings on their buccal surfaces, attached to teeth just beyond those bordering on the cuts. That is, if the bone section is removed from the site of the second premolar, the canine and second molar will carry the bands. Bands are placed on upper teeth that will correspond to the bands below after the jaw is cut. The fixation is made by passing a wire between the two lower bands and between each of the lower bands and the one above (Fig. 264). Here solidity will be gained by placing cement or softened gutta-percha at proper places between the

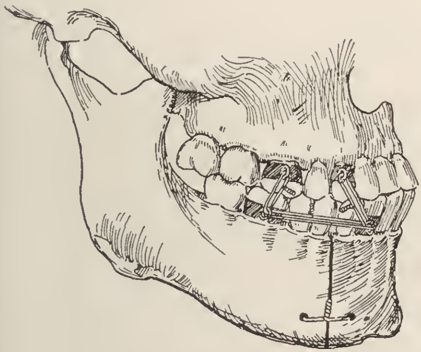


Fig. 264.

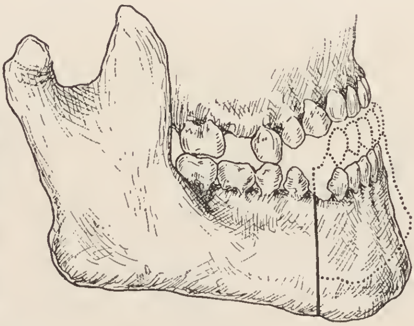


Fig. 265.

Fig. 264.—Fixation of the jaw by wires and bands, after removing a section from the body. (The lower wire should be shown, bent downward.)

Fig. 265.—Reconstruction of an open bite in a boy 16 years of age, due possibly to the very early crumbling away of the crowns of the deciduous molars which had occurred. Showing correction by simple section of the body of the jaw on each side.

occlusal surfaces, but space must be allowed for the taking of liquid food. We consider this the best plan of fixation.

The intraoral fixation and the lower fixation should be done together so that neither one will throw the other entirely out of balance, as might be the case if the cuts are badly made. The teeth can be moved later, and it is not necessary to have absolutely accurate bony contact.

The bone wires are twisted, bent down, and cut at the lower border of the jaw so that they can be found if it is necessary later to remove them.

## BABCOCK'S OPERATION FOR PROTRUSION OF THE LOWER JAW

If the protrusion is due entirely to a sliding forward of the body and there are no abnormal interdental spaces or supernumerary teeth, the means adopted by Babcock is surely the simpler and proper operation. Dr. Babcock exposed the ramus and cut it with a chisel, but we think the method of cutting the ramus, described under Retraction of the Jaw, has several advantages over the open operation. The jaw is to be fixed as after the operation of bringing the body forward, but the posterior wires must be so applied that they will hold the body backward, in place of forward. The teeth should be made to interlock so that the lower jaw cannot again push forward before the permanent callus completely fixes the bone.

## OPEN BITE

**Correction by Traction.**—A slight open bite in a child under twelve years may be corrected by the orthodontist. In older persons, the anterior teeth may be lengthened by porcelain crowns.

**Correction by Surgical Operation.**—If it is decided that an operation on the jawbone is necessary, a study of plaster reproductions of the dentures will reveal the character of the operation indicated.

## OPERATION FOR OPEN BITE

In some cases all that will be required is a simple section of the jaw on both sides, in front of the first tooth that occludes with those above; then the anterior fragment can be moved up to occlusion (Fig. 265). In others it will be necessary to remove a V-shaped section from the bone on each side, just in front of the first occluding tooth. The apex of this V-shaped section is at the lower border of the jaw, and usually a tooth must be extracted from the site of the section on each side (Fig. 266). The bone-cutting can be done from within the mouth with a Gigli saw or cross-cut fissure bur, but we believe it better surgery to operate from below as in the open operation for protrusion of the lower jaw. The method shown in Fig. 267 has the advantage of not shortening the lower jaw.

As before cited, the open bite is partially due to deformity of the upper jaw, and the surgeon must not expect to be able to entirely correct it in all cases by an operation on the lower jaw. A better

result will come from restoring the lower jaw to its proper form and correcting the remaining open bite, either by bringing down the upper incisors with an orthodontic appliance or by extending them with porcelain crowns.

**Fixation.**—The fixation is to be made as after a section of the body of the mandible for protrusion. If the teeth in the chin fragment are very poor so as to afford an insufficient anchorage, the mouth may be dressed open by means of a splint previously made on reconstructed plaster dentures. This will prevent the chin fragment from

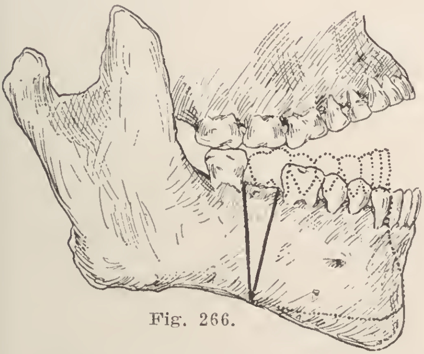


Fig. 266.

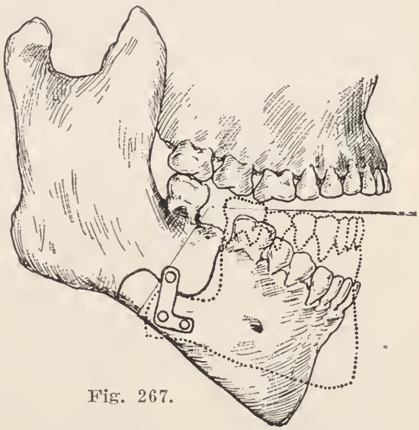


Fig. 267.

Fig. 266.—Open bite of an extreme type in a young man, showing how correction might be made by a V-shaped excision. This would have the disadvantage of shortening the jaw considerably, as shown in the reconstructed jaw indicated by dotted lines. The operation, shown in Fig. 267, was done in this case.

Fig. 267.—Showing operation by S-shaped bone-cut, that lengthens the jawbone and gives a better closure of the mouth. The silver splints at the site of the bone-cut are absolutely necessary, and increase the risk of sepsis. The bone spaces will fill in satisfactorily, but the transverse part of the "S" cut must be in hard bone.

being pulled down by the digastric and geniohyoid muscles. If the upper teeth will afford good anchorage, two silver wires may be passed entirely around the chin fragment and anchored to the teeth above (Fig. 50).

## ATYPICAL DEFORMITIES

In the classification of jaw deformities here given, we do not wish to convey the impression that we have systematized the whole subject, but rather, for convenience, we have made this grouping from the cases which have come under our observation.

There are other deformities which will have to be considered indi-

vidually, although on the general lines which have been laid down here. Contraction of scars from burns on the neck and chin can greatly affect the shape of the lower jaw. Although the title of the chapter does not include them, deformities arising from unreduced unilateral or bilateral dislocations, malunion of fractures, etc., are germane to the subject. They are to be corrected on these same lines.

## AFTER-TREATMENT

After the operation there will always be sufficient space between the teeth to take liquid and, in most cases, semifluid food. Nutrition and hygiene should be kept at the top notch. Rigid mouth asepsis before, during, and after the operation is the best preventive of sore and painful mouths.

# CHAPTER XXIV

## DISEASES OF THE MANDIBULAR JOINT—LIMITED MOVEMENT OF THE JAW

It is convenient to group together all conditions having as their principal clinical characteristic a limitation in movement of the lower jaw, although this may be dependent on a great variety of conditions either connected with the joint itself or with structures outside the joint.

Limited movement of the jaw may be acute or chronic. Chronic limitation is known as ankylosis, and may be true or false. In *true ankylosis* there are permanent changes in the joint structures themselves, while in *false ankylosis* the condition is dependent on chronic impairment or alteration of the soft tissues in the neighborhood which limit motion.

### ACUTE LIMITATION

#### Diseases of the Joint Itself

The mandibular joint is particularly liable to be affected by suppurative diseases in its immediate neighborhood, such as an extension of middle ear disease. It may also be the seat of gonorrheal arthritis, metastatic septic arthritis, or arthritis following scarlatina. Tuberculous arthritis of the joint is probably very rare. Acute arthritis may follow traumatism. Any of these conditions may be followed by a permanent ankylosis.

**Symptoms.**—The ordinary symptoms of acute arthritis are pain, tenderness and swelling in the region of the joint and limitation of opening of the mouth. If much fluid is present in the joint the condyle may be pushed forward out of the fossa, with consequent slight deviation of the chin to the opposite side. These local signs are usually accompanied by fever. Suppuration will be evidenced by edema, redness and fluctuation. It is somewhat difficult to distinguish between an intra- and a periarticular suppuration, and usually the pus is liberated only when it begins to point.

**Treatment.**—The most effective treatment of acute joint troubles is rest, with or without the application of heat or cold, which treatment is easily adapted to this joint.

In an acute painful condition the patient will hold the jaw fairly quiet, but in many subacute processes help can be gained by artificially limiting the movements of the jaw. As the mouth opens, the condyle of the jaw glides downward and forward over quite a large arc. By limiting the extent to which the mouth can be opened, the condyle can be confined to the posterior part of the fossa; the damage to an inflamed joint can in this way be lessened, and the ligaments given a better chance to recover. A head-and-chin bandage will partially control the motion of the jaw, but a more acceptable plan is to place a band on an upper and a corresponding lower premolar tooth, each band to have on its outer side a small ring through which is threaded a silk ligature which will limit the amount of opening. At first, the jaw may be allowed to open 5 or 10 millimeters, and later, as the condition improves, the excursion can be increased. The ligatures break frequently, but the patient can be taught to have some one at home replace them. If this treatment is adopted for some very active inflammation that might be followed by adhesions, the means for overcoming adhesions should be instituted as soon as the acute process has subsided.

The presence of suppuration demands drainage. The joint can be opened by a transverse incision along the lower border of the zygoma, from its middle back to the tragus. With care, by drawing back the tissues with retractors, the auriculo-temporal nerve and the temporal artery can be avoided.

### Hysterical Closure of the Jaws

Inability to open the mouth may be a hysterical phenomenon, which is most common in young women. The clinical history of the case and the lack of a definite lesion are the bases of the diagnosis. The patient is of a "nervous" temperament, and usually gives a history of having had similar attacks before, usually recovering rather suddenly. The attacks are, as a rule, associated with some mental strain or worry, and while the attack lasts, which may be for weeks, the amount of opening varies. Here, as with every other supposed hysterical manifestation, the diagnosis should be made only after very careful consideration. If necessary, the absence of physical lesion can be demonstrated by relaxation of the muscles under a general anesthetic.

The **treatment** consists in general treatment of the patient, encouragement, and assurance that the condition will disappear. In resistant cases, opening the mouth under a general anesthetic and

wiring a wooden wedge between the upper and lower teeth on one side for several days may be beneficial.

### Limitation Due to Reflex Irritation, or Trismus

An inflammatory process in the posterior part of the floor of the mouth, the cheeks, pharynx, external auditory canal or parotid gland may prevent the patient from opening the mouth on account of the pain it causes, but the limitation may be entirely involuntary with no pain, due to reflex irritation of an intraoral lesion. Disease of a lower molar tooth, particularly a third molar, is a common cause of reflex spasm of the muscles of mastication. When the source of irritation is removed, the spasm is at once relieved. There may be one or several muscles involved in the spasm. Periostitis of the outer surface of the mandible in the region of insertion of the masseter will cause a spasm of that muscle, which may be of comparatively long duration. The limitation may be directly mechanical, due to inflammatory masses, new growths, or malunion of fractures, and it should not be forgotten that tonic spasm of the jaw muscles is an early symptom of tetanus.

A radiographic examination should be routinely made in all cases for the location of septic or impacted teeth, periostitis, to demonstrate the presence of a foreign body or a fracture.

**Treatment.**—The treatment of acute reflex limitation of movement should first consist in removal of the cause, such as an impacted or septic tooth, drainage of suppurative periostitis or other collection of pus, removal of a foreign body, or fixation of a fracture. Hot moist applications will then aid in bringing about muscular relaxation. In some cases, the inflammatory condition will result in fibrous changes in the muscles and surrounding soft tissues, leading to chronic false ankylosis and demanding treatment of the contracture itself. This treatment will be given under the next heading.

### Chronic Limitation of Movement Due to Extraarticular Tissue Changes—False Ankylosis

False ankylosis may be due to trauma, such as gunshot wounds, with or without involvement of the bones, in healing of which there has been considerable formation of scar tissue either in the muscles or in the soft tissues anywhere between the joint and the symphysis of the mandible. Inflammatory conditions, such as those mentioned above under acute limitations, may be followed by organization of

exudate and formation of fibrous tissue (Fig. 268). False ankylosis may be due to scars following extensive intraoral ulceration, the result of salivation, noma, scarlet fever, or other acute exanthemata. It is frequently seen after treatment of malignant growths of the mouth by cautery, x-ray and radium. If the disease has occurred early in life, a lack of development of the mandible may result, with consequent retraction of the chin.

In false ankylosis, there will nearly always be some movement present. The cause of the limitation will usually be evident on examination. The amount of resistance encountered to attempts to separate the jaws should be treated by means of a wedge or mouth gag inserted between the teeth. In mild cases, this resistance may be slight

Fig. 268.—Radiogram from case of myositis ossificans of masseter muscle, following gunshot wound, causing false ankylosis.

and easily overcome by the gag. In others, it may be impossible to produce any separation beyond a certain point.

**Treatment.**—In false ankylosis resulting from muscular contracture, or the presence of slight adhesions or muscle infiltration, where no obvious obstruction remains, the resort to gradual dilatation of the jaws usually meets with success. It is recognized that a constantly acting mild interdental force, either by springs or rubber elastic, will accomplish better results with less danger of injury than sudden positive application of screw pressure acting powerfully for brief periods at repeated intervals. An initial opening of 1 cm. or more between the upper and lower incisor teeth can frequently be obtained in 24 hours by the spring force of the common clothes-pin, the ends of which have been trimmed down in the form of a wedge for insertion between the teeth, as suggested by Prinz (Fig. 269). In other

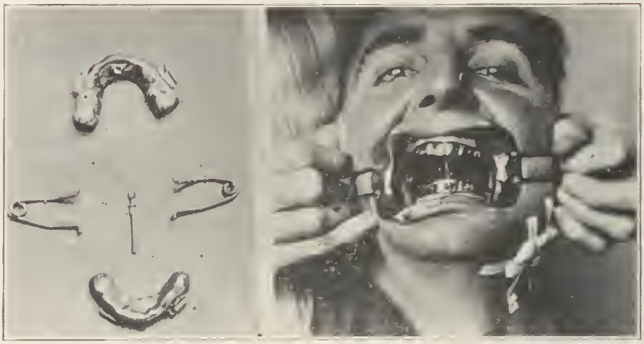
cases, the use of the spring-clip clothes-pin will be more suitable (Fig. 269). After the initial opening has been gained, some form of apparatus that can be worn more or less constantly by the patient is of advantage. As soon as sufficient opening has been gained to take impressions, an apparatus such as that shown in Figs. 270, 271 and 272. This consists of cast silver caps fitting over upper and lower

Fig. 269.—Two forms of clothes-pin useful in gaining initial opening in limited motion of the mandible.

Fig. 270.—Apparatus for constant use in treatment of ankylosis.

teeth, connected by wire springs. In addition to the springs which exert constant force, there is a vertical jackscrew in the median line in front to make positive pressure once or twice a day. The caps are not cemented to the teeth and may be removed at meal times. Once or twice a day the jackscrew is inserted and the nut is tightened as much as the patient can stand and allowed to remain for 15 or 20

minutes before the jackscrew is removed. Figs. 273 to 277 show an apparatus that presents many advantages over the forms hitherto employed for these cases, as it is not necessary to wait for sufficient opening to obtain impressions of the teeth, and there is no loss of time entailed in construction of the apparatus. This can be made as a stock appliance, in three sizes, ready for immediate use where



*a* *b*

Fig. 271.—(*a*), Same apparatus disassembled. (*b*) Same apparatus worn by patient after operative removal of bone in masseter muscle.

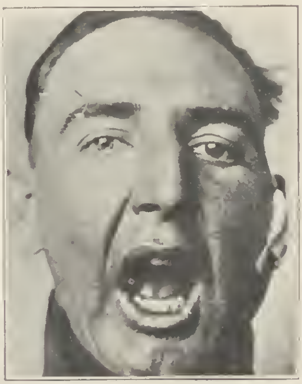


Fig. 272.—Same patient as Fig. 271*B*, after use of apparatus.

there is an initial opening between the teeth of 1 centimeter. It can be easily fitted, and is practically as stable as an apparatus that has been made from dental impressions of the individual. The construction is extremely simple, the two parts being flat metal trays passing between the occlusal surfaces of the upper and lower teeth (Fig. 273). To the outer sides of each tray are soldered heavy wires which pass out of the mouth and curve backward over the cheeks in the manner

of Kingsley splints. The wire attached to the upper tray on each side turns down at a right angle about opposite the premolar region and ends in a hook about three inches lower down (Figs. 274, 276). The wire attached to the lower tray passes directly backward horizontally and is provided with a hook at a point opposite the down-

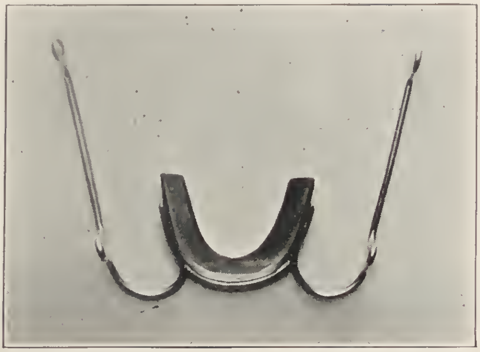


Fig. 273.—Lower tray of universal trismus apparatus.

Fig. 274.—Lateral view of universal trismus apparatus on skull.

ward turn of the upper wire. The dilating force is a heavy elastic band placed between these hooks on each side (Figs. 274, 275, 276, 277). This application of dilating force in the manner described is original with Darcissac of Paris (*Dental Cosmos,* March, 1922, p. 356), who has proved its value in numerous cases. Darcissac, how-

ever, made individual apparatus from impressions of each case, casting metal caps to fit the teeth. The advantage claimed for the present appliance is that it is ready for immediate use in any case with not less than one centimeter of separation, without the necessity of im-

Fig. 275.—Front view of universal trismus apparatus on skull.

Fig. 276.—Lateral view of universal trismus apparatus on patient.

pression-taking. The elastics produce a constant counteraction to the powerful elevator muscles of the mandible, which at the same time are permitted to function, the upper and lower jaws being at no time fixed. Lateral movements as well as opening and closing are

possible. Where additional stability is desirable the trays may be filled with a little softened impression compound before insertion, to receive the imprint of the teeth. This compound can be renewed from time to time. The dilating force can be regulated by the size and tension of the elastic bands. In some cases, where it is advisable to aid in the forward movement of the condyle as the mouth opens, this can be accomplished by running a second rubber band between the hook on the wire attached to the upper tray and one placed at

Fig. 277.—Front view of universal trismus apparatus on patient.

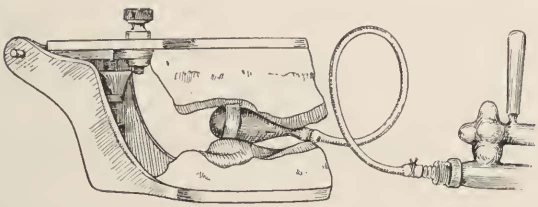


Fig. 278.—Showing an apparatus, which was made for us by J. A. Brown, for a man who had a strong fibrous ankylosis of long standing, and whose remaining teeth were loose. It consists of an upper and a lower vulcanite plate which fit evenly over the gums and teeth. Between these is placed a small thick-walled rubber bag attached to an air-pump by a tube. Dilatation is accomplished by forcing air into the bulb. This is in use at present, and is accomplishing a satisfactory result. The bulb is held in place by a strip of elastic dam. The bulb must be made very thick and strong, and it must not touch the tongue or palate.

the extreme posterior end of the lower wire. The apparatus can be removed at meal times or whenever desired, and replaced by the patient or some one in the house with him.

Under this treatment the average case should show from 2 to 4

mm. improvement per day, and a permanent opening of 30 mm. between upper and lower incisor cutting edges, which is sufficient for all practical purposes, should be gained in about one month.

Where there are no teeth or where the teeth are loose in their sockets, some other plan of dilatation will have to be adopted (Fig. 278).

**Operative Treatment.**—In cases which do not respond readily to the gradual stretching process and in which some obvious cause for the limitation of motion is present, operation for removal of the cause and to obtain full separation of the jaws is indicated. Operation should in all cases be followed by the wearing of an apparatus for the maintenance of the width of opening until there is no further tendency to contracture. Whenever possible, impressions should be taken and the appliance made before operation, so that it will be ready for insertion immediately afterward. We have seen many cases where operative interference proved useless owing to loss of time in inserting the appliance. Before resorting to operation the exact location of the restricting lesion should be determined. In the case of muscular adhesions, the particular muscle fibers involved, whether masseter, temporal or internal pterygoid should be divided to permit of the full opening. Narrow oral scar bands may be cut or dissected out, and the buccal mucous membrane can be stitched in such a way as to fill the gap that is left, but no permanent good can be expected from simply cutting dense adhesions, which leave a broad, raw surface to granulate. As the wound heals, it will contract, and the condition will not be in the least improved.

The raw surface may be epithelialized by covering it with Thiersch skin grafts, as described in Chapter XXII. For more marked cases of closure of the mouth by intraoral scar bands, we prefer the following procedure, because, being based on good surgical principles, when properly done, it will disappoint neither the patient nor the operator.

**Operation by Flap Transplantation.**—The scar, or nearly all of it, is excised, and the soft tissues dissected from the periosteum of the jaws, above and below, to restore the natural depth of the culdesacs. Scar that extends from the cheek to the face, especially at the corner of the mouth, is treated at the same time. To satisfactorily remove some intrabuccal scars, it may be necessary to turn up the cheek in the form of a flap by an incision running from the angle of the mouth to the border of the jaw and then back along this border, as in operating for carcinoma of the inner surface of the cheek. This

will be followed by paralysis of the depressor anguli oris muscle of this side, which does not cause a very noticeable deformity. If one is certain that after removing the scar the nutrition of the lower lip will be preserved, the lip and chin can be split in the median line, and half of it turned aside with the cheek. We think its nutrition may be considered safe if the coronary artery is intact. In removing the scar from the inner surface of the cheek, the opening of Stenson's duct should be identified and preserved. The next step is to turn a flap from the neck and suture it to the raw surface in the cheek. Especial care should be taken to stitch the edge of the flap high up on the outer surface of the maxilla so as to be certain to restore the culdesac. Later, scar contraction of the uncovered granulating surface of the bone will pull down the border of the flap and lessen the depth of the newly made fornix. If the raw surface entirely surrounds the opening of the parotid duct, a small hole is to be made in the flap and the edges sutured around the mouth of the duct. If the opening of the duct cannot be identified, drainage through the flap must be provided. Otherwise healing will be complicated by having the space between the flap and the cheek fill first with saliva and then with pus and saliva.

The epithelial lining of the cheek having been restored, any deformity or deficiency of the cheeks or lips is repaired by flaps that were planned before the operation.

After ten days, if extensive primary union of the transplanted flap has occurred, after a longer period if one is not certain that the new blood supply is ample, the base of the flap is cut, and the defect in the neck repaired. If, after the scar has been removed and the resulting defect filled by a well-nourished flap of skin and subcutaneous fascia, the mouth can be opened a desirable distance, the surgeon may feel satisfied that the contraction will not return. The transplanted skin soon takes on an appearance somewhat resembling the mucous membrane, and in our experience has never shown any irritation in its new location. If, after excising the scar, it is found that the mouth cannot be opened sufficiently, an operation on the joint will be required. The patient should be cognizant of this possibility before the first operation is performed.

### Limitation of Movement Due to Permanent Changes in the Joint Structures Themselves—True Ankylosis

Here, there may be a fibrous union of the structures composing the joint, or an actual bony fusion of the parts. True ankylosis may

follow any of the suppurative conditions of the joint, either resulting from extension of infection from local structures, such as the middle ear or from metastatic septic arthritis. It may be present in osteo-arthritis, a chronic disease in which many of the joints of the body are progressively affected by ossification of the joint structures. Bony union of the joint surfaces and surrounding parts may also occur after severe traumatism, such as a blow or fall on the chin, in which the main part of the force is received in the region of the condyle.

**Deformity.**—After prolonged ankylosis, especially when dating back to early childhood before full development of the mandible, a

Fig. 279.—Showing child at five years, who, probably as the result of injury, had a double fibroosseous ankylosis existing for two years. A resection was made of both joints, which gave a free opening of 2 centimeters. No attempt was made to bring forward the body of the jaw, for, on account of the age of the child, we thought the jaw would develop after an opening was established.

characteristic deformity has been pointed out by Cryer. The condyloid process is shortened. This causes an apparent elongation of the coronoid process. The angle of the mandible is elongated, so that it forms a point projecting downward, and the base of the bone under the mental foramen is thickened. The mental process is much diminished in size, causing an apparent recession. The base of the bone, between the angle and a point vertically under the canine region, is deeply concave in outline. The cause of these changes lies in the activity of the muscles that depress the jaw. The muscles of

mastication—i. e., those which elevate the lower jaw—are inactive, while those which assist in depressing the mandible become more and more active in an endeavor to overcome the fixation of the articulation. By their action the lower jaw, from the symphysis to the angle, becomes modified in proportion to the contraction of these depressor muscles. Anteriorly, there are the genio-hyoglossus, the geniohyoid, the stenohyoid, the sternothyroid, the digastric, the omohyoid and the platysma muscles, all of which are abnormally active. Their action without the compensating factor of the mandibular motion brings about the changes noted.

Fig. 280.—X-ray showing condyle, coronoid process, and ramus in a normal joint.

**Symptoms.**—Absolute immobility of the joint is rare. Even with bony fusion, it is generally possible for the incisor teeth to be slightly separated, but never more than five millimeters. If the ankylosis has taken place after the jaw has attained its full growth, visible deformity is usually absent. If ankylosis dates from childhood, the typical deformity described above will be noted. The teeth are found to be irregular and some of them impacted, owing to lack of space for eruption. Many of the teeth are generally carious. A point of difficulty frequently presenting is to determine whether the ankylosis is bilateral, or if unilateral, which of the two sides is affected. Good x-ray negatives will often be of value in clearing up these points

(Figs. 280 and 281). It has been our observation that, in a unilateral close fibrous ankylosis, in attempting to open the mouth, the chin deviates to the ankylosed side. This is due to a slight twisting motion at the damaged joint, while the uninjured condyle travels on an arc with the other one as a center. The face on the ankylosed side is full and round and apparently normal in appearance. On the unaffected side it is flattened and deformed. Misinterpretation of this deformity has in many cases led to operation on the unaffected side first. The chin is more or less retracted and deviated to the ankylosed side.

Fig. 281.—X-ray showing true bony ankylosis of the joint.

Contrary to what might be expected, patients with long standing ankylosis are usually well nourished, and are able to partake of solid food to a surprising degree.

**Treatment.**—Correction of true ankylosis requires operative formation of a new joint (pseudoarthrosis). Esmarch's operation consisted in removing a wedge-shaped piece of bone from the angle of the mandible and interposing some foreign material, such as gutta-percha, to prevent reunion. It is now generally recognized that the new joint should be made as near the normal position as possible, viz., through the region of the neck of the condyle.

**Technic of the Operation.**—The hair is shaved to a point 5 centimeters above the level of the ear and back to the level of its posterior border. The parts, including the remaining hair, are cleansed,

Fig. 282.—Showing line of incision for excision of the temporomandibular joint. The area within the broad pencil marks was temporarily anesthetic afterward.

Fig. 283.—X-ray showing condition after the condyle and coronoid process are removed for ankylosis.

and in women the hair is braided so as to draw it away from the field of operation. After the final preparation of the skin, the hair in the neighborhood is plastered down with sterile adhesive plaster. Before

applying the sterile cloths, the incision is outlined with the point of the knife. This incision extends from in front of the lobe, upward just in front of the ear to a point 1 centimeter above its free upper border. From here it curves forward and then downward to a point 2½ centimeters directly in front of the upper end of the attachment

Fig. 284.

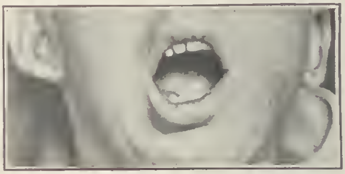


Fig. 285.

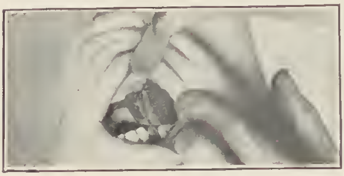


Fig. 286.

Fig. 287.

Fig. 288.

Fig. 284.—Showing opening of the jaws in a case of fibroosseous ankylosis in a young man 22 years of age, in whom the joint on one side had been injured 11 years previously by the kick of a mule. The movements of the jaw had gradually lessened until the opening between the incisor teeth was 1 centimeter.

Fig. 285.—Same case as shown in Fig. 284, after excision of the joint. Opening between the incisor teeth 24 millimeters.

Fig. 286.—Case shown in Fig. 284, immediately after operation. Mouth held open with a pine block.

Fig. 287.—Case shown in Figs. 284 to 286, one year and nine months after operation. Opening between incisor teeth 35 millimeters.

Fig. 288.—Showing opening that was obtained in a case of single complete ankylosis, after cutting the rami and drawing forward the body. Later this opening decreased, and the ankylosed joint was reconstructed with a permanent good result.

of the ear (Fig. 282). After this incision is outlined, the field is protected above, behind, and below by sterile cloths that are pinned in place, but the whole of the facial distribution of the seventh nerve

should be left entirely within the operator's unobstructed view. The anesthesia had best be carried on by intrapharyngeal ether vapor introduced through nasal tubes.

The incision already indicated is carried through the skin only, and the skin flap thus outlined is dissected downward, retaining with it only sufficient tissue to insure its nourishment; the subjacent superficial fascia is to be used in making the new joint.

The second step consists in incising the superficial fascia down to

Fig. 289.—Shows girl of 16 years, in whom, as a result of an infectious arthritis, there was an almost complete fibroosseous ankylosis of the right side—first noticed at 3 years. At 16 years she had an opening of 3 millimeters on the right and of 4 millimeters on the left in the canine region. The right condyle was excised, and a new joint made. The left ramus was sawed in two, and the body dragged forward and wired in its position. Later a piece of her seventh costal cartilage was implanted in front of the mental part of the body of the jaw. Shortly after unwiring the jaw, she had an opening of 18 millimeters.

the temporal and parotid fasciae and the zygoma along the line of the skin cut, dissecting it up from the subjacent tissues to the same extent as the skin flap. In doing this, only the posterior three-fourths of the incision in the superficial fascia should be made at first, as the anterior end of the incision will cross the branch of the seventh nerve that supplies the anterior belly of the occipito-frontalis muscle. This

flap should contain the temporal artery to insure its vitality. In extending the incision forward, a section of fascia should be grasped sharply in a pair of pointed artery forceps before being cut. If a motor nerve is sharply pinched, there will be a contraction of the muscle it supplies. If necessary, the fibers to the occipito-frontalis may be cut or stretched, but on no account should fibers of the orbicularis palpebrarum be disturbed.

The posterior part of the masseter, with the fascia covering it, is to

Fig. 290.—Case shown in Fig. 289, eight months after first operation. She has an opening of 22 millimeters, has gained considerably in weight, and her general appearance and mode of dress show her improved disposition.

be freed from the zygoma, and the muscle dragged downward and forward with a small, strong, hooked retractor. This will expose the site of the joint, which may be found surrounded with dense adhesions or an overgrowth of bone, or there may be a true ankylosis.

If by cutting the periarticular bands the mouth can be opened and the interior of the joint appears normal, this might be all that would be needed, but we have never encountered such a case. Usually the condyle will have to be resected, or the bony connection dug out with

grooved chisel and a small rongeur (Fig. 291). To one accustomed to work with them, burs driven by an engine would do effective work, but it is to be remembered that the internal maxillary artery and part of the third division of the fifth nerve lie immediately subjacent to the bone.

The serious question has occurred to us, in removing both condyles simultaneously, of the possibility of the masseter and internal pterygoids drawing the mouth permanently open. In one case of a five-year-old child we removed both condyles at the same time, and the child closes its mouth perfectly. Simple excision of one or both con-

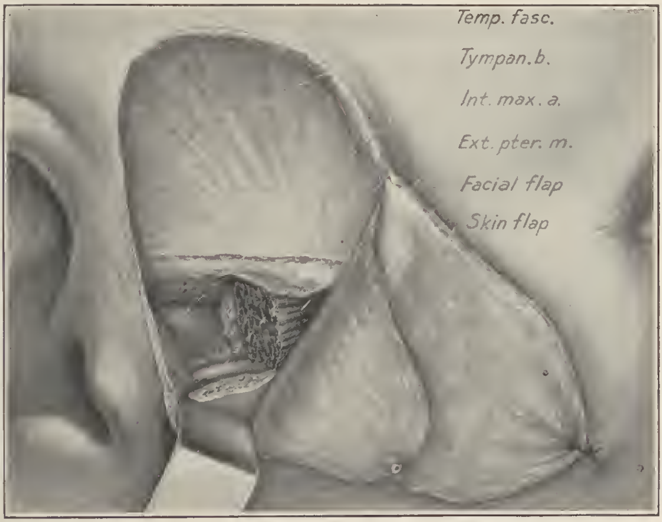



Fig. 291.—Showing cavity remaining after removing ankylosed condyle. Also flap of fascial tissue that is to be sutured to the bottom of the cavity.

dyles for ankylosis is an old operation and, as far as we know, has not been followed by inability to close the mouth.

A true ankylosis will usually obliterate the sigmoid fossa and involve the coronoid process. If possible, a part of the insertion of the temporal muscle should be preserved, but this is rarely the case. The ankylosis having been freed, the mouth is opened. Even where there has been no injury or disease of the joint of the opposite side, this may not be easy and may require a strong dilator. Judgment must be used; for it is in just such a case that the jaw may be fractured or several teeth pushed out. If the mouth cannot be opened, the operation must be repeated on the opposite side. A 2-centimeter space between the upper and lower canine teeth is a practical amount.

If the jaws are forced too wide apart, the muscles of mastication might be injured beyond recovery. If the bony and ligamentous resistance has been overcome, the amount of the opening will subsequently increase with use. (Figs. 284 to 288.) The joint is made permanent by suturing the flap of superficial fascia to some soft tissue at the bottom of the defect, left after removing the condyle. Before doing this, hemorrhage must be controlled so as to obtain a clear view. The artery, vein or nerve might be injured in passing this suture. If the original incision has not been carried sufficiently high on the temple, the fascial flap may be too short; it could be lengthened by cutting downward in front, but injury to the palpebral fibers of the motor nerve must be avoided. If the flap is absolutely too short, the zygoma may be cut, and a section of the temporal fascia substituted for it. The flap having been sutured into the new joint, the skin wound is closed with a rubber drain extending to the depth of the new joint and let out in front of the tragus. This drain should be sutured to the skin. Usually our next step is to fix the mouth open by wiring a smooth block of pine wood between the molars on one side, that will separate the jaws about 2 centimeters. This will cause some discomfort, but will insure a free opening. The patient will be able to close the jaws within twenty-four or forty-eight hours after removal of the block. A free motion will develop and will increase with time. If there is the retraction of the chin that always accompanies a very early ankylosis, the ramus may be sectioned on the sound side, and the body drawn forward and held in place by wiring the upper to the lower teeth. At the end of ten or twelve weeks the wires are removed, and the opening gradually restored with rubber wedges. The chin may also be given its full prominence by bone or cartilage grafting.

As with any operation around the parotid gland, a temporary paralysis of the muscles supplied by the seventh nerve may follow, becoming evident within the first two days. This is chiefly evidenced by the eye remaining open while asleep. It should not cause worry, for, according to our observation, it always disappears in three to five weeks. Paralysis due to direct injury of the nerve comes on immediately. If one were unfortunate enough to cut the whole supply of the orbicularis palpebrarum, the nerve should be sought and sutured immediately. In one case we had a partial injury to the nerve supply of the muscle, but ability to close the palpebral fissure was restored within six months.

# CHAPTER XXV

# AFFECTIONS OF THE SALIVARY GLANDS AND THEIR DUCTS

The salivary ducts and glands are occasionally the seat of congenital abnormalities; congenital atresia of the duct has caused cystic formation. The glands may be found displaced from their normal site, or the duct openings may be in an abnormal position.

## INFLAMMATION OF THE LARGER DUCTS

Formerly it was rather generally accepted that most infections of these glands were of a metastatic origin, but now there is considerable evidence to show that most, if not the vast majority, of these occur through their excretory ducts. Even in the so-called secondary infections of the salivary glands, it is probable that the infection is accidental, occurring from the mouth through the duct.

The most common instance of inflammation of a duct is in connection with a stone or a foreign body; but a duct may become inflamed without the presence of a foreign body or a stone. In the early stages of an extensive inflammation, the mouth of the duct will be found open, and the mucous lining everted. If the duct is squeezed, a drop of pus may exude. When the inflammation is dependent on the presence of a stone or other foreign body, recovery usually follows quickly after the removal of the mechanical irritant. When the inflammation develops in the absence of any mechanical irritant, it is often of a chronic, persistent character, and there is a dilatation of the duct and a thickening of its walls. The tube may become so patent that air can enter it. It is supposed that this phenomenon has been observed most commonly in glass-blowers.

Besides those symptoms already noted, there often occurs during eating the ordinary symptom of acute obstruction due to a foreign body in the duct (see page 398). This is due to a plug of mucus or fibrin. Secondarily, the gland may become permanently enlarged. Usually the result of treatment in chronic simple inflammation of the ducts is not particularly satisfactory, but in the earlier cases and in those giving obstructive symptoms, help can be afforded. The duct should be sounded to exclude a foreign body; this being absent, the

duct can be irrigated once a day with a 5 per cent solution of argyrol or colloidal silver, or a 1:2000 solution of potassium permanganate. The injections are best made with a long probe-pointed needle. In older cases the gentle dilatation of the duct with a sound before injection might be helpful. In all cases, however, the injections should be made gently, and it should be seen that the fluid returns freely.

If there is a blocking or stricture of the duct at or near the orifice, this may be relieved by slitting the duct with probed scissors or on a grooved director. The inflammations that follow injuries or accompany stones and foreign bodies may be of any grade, from a subacute mild suppuration to virulent spreading phlegmon, but are usually of the former grade.

## EPIDEMIC PAROTITIS (MUMPS)

Although commonly called parotitis, the disease often affects the other salivary glands and may even affect these without involvement of the parotid. It is an acute, contagious, non-suppurating infection of one or several glands and their ducts, preceded by a stomatitis. It may become epidemic in barracks, etc., but most commonly affects children. At first one gland is involved, usually the left parotid, the other as a rule being infected later. The skin over the swelling becomes edematous. This swelling may be rather extensive, and there is always moderate fever. The disease begins to subside in about a week, and all traces of the swelling are gone in from two to four weeks. Recovery almost always follows, but in a number of cases there is an accompanying swelling of one or, sometimes, both testicles, which may be followed by permanent atrophy. Occasionally it is accompanied by other complications, such as oöphoritis, mastitis, vulvovaginitis, inflammations of the urinary tract or of the eye and ear, or encephalon.

## ACUTE SUPPURATIVE INFLAMMATION OF THE SUBMAXILLARY AND SUBLINGUAL GLANDS IN YOUNG INFANTS

In the first few weeks or months of life, infants may be affected by an acute suppurative inflammation which is accompanied by swelling of these glands, discharge of pus from their ducts, and the formation of intraglandular abscesses. In otherwise healthy infants recovery usually takes place, but the glands should be opened as soon as the formation of confined pus is suspected.

## SECONDARY INFECTIONS AND SEPTIC PAROTITIS

Acute septic infection of the salivary glands is most commonly seen in the parotid. This is often referred to as a secondary or metastatic parotid abscess. Formerly it was rather generally accepted that the acute septic infections of these glands were metastatic; later considerable evidence accumulated to show that most, if not nearly all, were ascending infections of the excretory ducts; and the fact that the stomata of both the submaxillary and the parotid ducts are at the apices of mucous papillae suggests that an effort has been made to protect them from contamination caused by foreign bodies or fluids entering from the mouth. The later work of Rosenow on infection of the bile-ducts must, however, make us hesitate before entirely condemning the metastatic idea. Neither theory has ever been demonstrated beyond dispute. Be this as it may, during the acute stage of some infectious fever, toward the period of subsidence, or a few days after some operation, supposedly more common after operation on the ovaries, a swelling may appear in one or both parotids; less commonly in one of the other salivary glands. In the parotid the swelling is usually first marked in front of the lobe of the ear, where the capsule is less tense, but subsequently the swelling is evident over the whole gland. In fulminating cases the swelling may come up very rapidly, and the involvement of the parotid be obscured by the edema of the cheek and neck. The appearance of the swelling is accompanied by fever and the other ordinary symptoms of septic infection; occasionally by discoloration of the skin, and often there is severe pain and tenderness, most marked over the parotid. These patients frequently present evidence of being extremely ill. Within the mouth there is usually some swelling of the parotid papilla, and at its apex may usually be seen a minute, dark-red spot which we have interpreted as being a visible part of the swollen mucous lining of the duct. The flow of saliva from the duct may be entirely suppressed, or pus may be squeezed out. In milder cases the symptoms may subside in a few days or go on to localized suppuration. The infection is often of a severe grade, however, causing diffuse phlegmon of the gland, which may spread to the surrounding tissues. Even these severe cases can usually be spared by prompt treatment, if the infection is confined to the parotid; but fulminating, septic parotitis is frequently but one expression of a general severe sepsis in a debilitated patient, and here treatment of the parotid may do nothing more than contribute to the comfort of the patient's few remaining hours.

**Treatment.**—In the earlier stages, ice should be applied. If suppuration occurs, it will usually be on the third or fourth day and be accompanied by an increase of all symptoms. This is the proper time for radical treatment. If specially tender or softened spots can be found, these may be opened by an incision down to the capsule. A round-nosed conical artery forceps should then be inserted, but in the presence of severe symptoms the surgeon should not wait for definite fluctuation, which, owing to the tenseness of the capsule, may never be evident. In such cases radical treatment may be urgently necessary within twenty-four hours after the first appearance of symptoms. Here, in the absence of any local softening, an incision should be made just in front of the ear from the zygoma to the angle of the jaw down to the capsule and the flap forcefully drawn forward with retractors. If there is edema of the neck the incision may extend to the clavicle through the deep cervical fascia. The trunk and branches of the 7th nerve lie deep in the gland, near its posterior part, and will not be injured by any carefully made incision. In this way, nearly the whole gland can be exposed. By incisions carefully made through the capsule, the swollen gland will be permitted to expand, which will increase its blood supply and lessen the danger of gangrene. If pus does not come on opening the capsule, the substance of the gland can be explored at various points by inserting a round-nosed artery forceps, not overlooking the prolongation of the gland that runs forward with the first part of the duct. If the more radical exposure of the capsule is made, the latter should be incised in a number of places, thus liberating pressure in every part of the gland. Failure to do this in one of the writer's cases made it later necessary to reopen the capsule of that part of the gland that runs forward with the first part of the duct. The operation requires but a few minutes under a gas anesthesia, and the wound is packed wide open. Where the pus is not liberated by incision, it has been reported to have most frequently ruptured into the external auditory canal, but it may make its way into the deep spaces of the neck, into the postpharyngeal space, into the mandibular joint, or through the olivary foramen into the cranial cavity. By thrombosis of the contained veins, the infection may spread to the cranial cavity, or pyemia may result. The submaxillary and the sublingual glands are to be treated by direct incisions, or if the inflammation is diffuse, by the writer's incisions for Ludwig's angina.

## CHRONIC INFLAMMATION

Following any of the chronic intoxications—such as lead, bismuth, opium, uremia, etc.—a subacute swelling may develop in both parotids, or in any of the salivary glands, causing diffuse swelling. They swell slowly with occasional attacks of acute inflammation. The ducts may share in the process. The tendency is toward spontaneous recovery.

Treatment consists in eliminating the source of poison. Oral hygiene should be practiced in all cases. Dry heat from an electric light should be applied, or the counterirritation of iodin. Potassium iodid, internally, has been recommended.

## PSEUDOHYPERTROPHY (MIKULICZ'S DISEASE)

Under this head has been described a chronic symmetrical enlargement of the salivary and lacrymal glands. With these, the palate glands, Blandin's glands, the labial and buccal glands, the lymph nodes, and the spleen have been observed to be enlarged in different cases. The disease comes on without other symptoms than the swelling, which is strictly limited to the glands and does not involve extracapsular structures. The glands of both sides are not always involved to the same extent. The tumors are usually, but not always, rather firm. According to Hirsch, the enlargement is due to an infiltration of round cells, which is accompanied by an atrophy of the secreting epithelium and a change of the round cell infiltration into connective tissue. He therefore regarded it as a cirrhosis of these glands. Besides the swelling, there are few symptoms, except those referable to the decrease of secretion—mostly dryness of the mucous membranes. Nothing definite is known of the cause, and the course is uncertain. In some cases the glands enlarge for a time and then remain stationary; in others they recede. Good results have been reported from arsenic and potassium iodid. Total excision may be resorted to in appropriate cases.

## SPECIFIC INFECTION OF THE SALIVARY GLANDS

**Tuberculosis.**—Tuberculosis of the salivary glands is a very rare occurrence and is to be distinguished from tuberculosis of a contained lymph node. There have been very few cases reported of apparently primary infection of the salivary gland, most all occurring in other-

wise healthy individuals. It has always been chronic, appearing as a diffuse swelling, a node or cyst, with few subjective symptoms. The diagnosis from tumors is to be made only by the microscope. The treatment is excision. The whole submaxillary gland should be removed, but a local operation may be done on the affected part of the parotid. This result of this treatment in the reported cases has been very good.

**Syphilis.**—Syphilis of the salivary glands is also extremely rare and has usually occurred in cases of the more virulent type. It has been observed by Newman that in the earlier stages of the disease the gland presents a diffuse painful swelling, but it is usually a late manifestation of either a gummatous or interstitial fibrous type. Usually there are other marked signs of syphilis, but an immediate absolute diagnosis from malignant tumor, which it may closely resemble, is only to be made by the microscope; though a positive Wassermann would of course be suggestive, and the disappearance of the swelling under antisyphilitic treatment is almost conclusive.

The treatment is the same as for other manifestations of syphilis.

**Actinomycosis.**—This may be part of a neighboring infection, or it may have gained entrance to the gland through the duct. The diagnosis in the later stages, after sinuses have formed, is to be made by the finding of the fungus.

The treatment is the same as that for the same infection at other sites.

## OBSTRUCTION OF THE DUCTS OF THE SALIVARY GLANDS. CYSTS

The ducts may be partially obstructed from calculi, swelling or neighboring cysts, swellings, or tumors. Plugs of mucus, foreign bodies, or even small calculi plugging the exit of a salivary duct will cause an accumulation of fluid which, if it persists, may cause a dilatation of all of the ducts emptying into the obstructed one, converting all into an epithelial-lined cavity. In the sublingual glands, the terminal ducts of which are small and numerous, the plugging of one of them is more liable to be permanent, which constitutes one of the forms of ranula. In the submaxillary and parotid glands, both of which empty their secretions through a long duct of comparatively large caliber, permanent obstruction rarely occurs.

The symptoms of an acute obstruction of one of the large ducts are: great pain, made worse by eating or the sight of food; and a

fusiform swelling corresponding to the duct, with swelling of the whole gland. (Fig. 292.) If the obstruction is not relieved naturally, or by passing a sound or by slitting the duct, suppuration may follow. In partial obstruction there are pain and swelling of both the duct and gland whenever the secretion is stimulated, but this subsides as the accumulation of saliva gradually forces its way out. Partial obstruction of the larger ducts is much more common than complete obstruction, and when caused by the inflammation around a stone or other foreign body, is likely to be recurrent. In the few cases that have been reported of permanent distension of the parotid or submaxillary duct, the obstruction has in most instances been due

Fig. 292.—Swelling of submaxillary gland due to calculus in Wharton's duct.

to a scar stricture or a foreign body. In a few the obstruction was congenital, and in others there was a cystic distention of the duct without any demonstrable obstruction. In the latter cases the secretion could be expressed out of the duct, but would reaccumulate. According to laboratory experiments, absolute occlusion of the main excretory duct causes atrophy of the gland. This does not agree with the accepted idea that most ranulae are due to sublingual duct obstruction.

**Diagnosis.**—The diagnosis is easily made from the location of the swelling and the increase of symptoms, which occurs during eating or even at the sight of food, due to the increased flow of saliva. If

convenient, an x-ray picture should be taken to locate a possible stone, but if this is not convenient and a stone or foreign body is suspected, search is to be made with a needle. (See page 402.)

**Treatment.**—An attempt should be made to pass a fine probe into the duct, which may dislodge or locate the obstruction. As large a probe as will easily enter the duct should be selected, but no force should be used, as a false passage might be formed. It may be possible to massage a foreign body out of the mouth of a duct. If the obstruction can be located and is not completely relieved by the passage of the probe, it should be cut down upon and removed as early as possible. A stone, responsible for the inflammation or scar contraction which is causing the obstruction, may have dropped back and may be found lying free in the cavity when the cyst is opened. If no definite cause for the obstruction is found and it cannot be relieved by simply passing a probe and frequently emptying the duct, then the cystic dilatation of the duct should be freely incised. Then, if no foreign body is present, further treatment may not be needed, for the frequent discharge of saliva from a large duct will probably maintain a permanent fistula. Should this treatment fail, a piece of the outer wall of the cyst can be removed with its mucous covering. Another plan is to use a silk or twisted silver-wire seton.

## FOREIGN BODIES AND STONES IN THE DUCTS AND GLANDS

Improbable as it may seem, foreign bodies—such as pieces of grain, apple seeds, bits of tartar, etc.—have occasionally found their way into the submaxillary duct, causing acute obstruction. In other instances the obstruction has not been complete, and no obstructive symptoms were noticed until inflammation occurred around the intruder. Only slender bodies, such as fish bones or bristles, can enter the opening of the parotid duct, on account of its smaller size. With the exception of calculi, which are formed in place, foreign bodies reach the glands only from without. If a body in the duct is not removed, suppuration usually sooner or later supervenes with symptoms of partial or complete obstruction. Foreign bodies which have entered a gland and healed in place are less likely to cause symptoms. A bullet may heal in place. A foreign body in the duct will in time become coated with lime salts, when it is to all purposes a salivary calculus.

The diagnosis of a foreign body, unless it can be seen or the history of its entrance is clear, is only tentative until it can be exposed or

felt. (For methods of examining for foreign bodies, see Examination for Stones, page 402.) A soft body will not cast a shadow upon the x-ray plate and can with difficulty be felt with an exploring needle. On the other hand, they are usually situated near the orifice of the duct, where they can be felt with a probe. The treatment is the same as for stones.

**Salivary Calculi.**—Salivary calculi can form in the glands themselves, or in their excretory ducts, the latter being the more common situation. Calculi in Blandin's glands, though not salivary glands, are included under this heading. Calculi form in the salivary glands and ducts less frequently than in the kidneys or liver. Though some of them may have as their matrix some foreign body which has entered the duct, it is probable that, like stones in other situations, they most frequently owe their origin to the presence of bacteria; these, together with a change in the mucous secretion, which they cause, furnish the matrix of the stone. A matrix of a stone having once formed, the same conditions of metabolism which influence the rapidity of the deposit of tartar on the teeth must also influence the rate of stone formation in the ducts.

The most common location of salivary calculi is in the submaxillary duct, being more frequent here than in all other locations combined. They are more common in men, and rarely occur in children, but have been congenital. Usually there is but one stone, the size of a pea or smaller, but they may be of large size—one reported by Pusey having reached the dimensions of ½ by 1 by 1½ inches and weighing 7.6 grams. There may be more than one stone, the size of the stones being smaller when there are a number of them. When the stones form in the secondary ducts of a gland, there may be a great number of them, which are apt to be thrown into the common duct, there to collect or to be thrown off through the normal opening.

A stone in a duct may cause no symptoms for a long time and will not do so until there is partial obstruction, or until a pus infection occurs. The symptoms of partial obstruction of a duct are given on page 398. Infection around a stone is accompanied by swelling, usually pain, and possibly suppuration or a diffuse cellulitis. As the result of one or repeated inflammations, the stone may come to lie in a bed of scar tissue, in an abscess, in the bottom of a fistula, or in a mass of fungating granulations and indurated tissue. The last condition has several times been mistaken for a malignant growth, and extensive, mutilating operations have been performed. When the stone lies in an indurated mass, which has attached itself to the bone,

it may be mistaken for a periosteitis, and the real cause overlooked. If untreated, a stone may lie in its bed indefinitely, with or without marked symptoms, or may eventually ulcerate its way through into the mouth, less rarely to the external surface.

The diagnosis is to be made partly upon the symptoms referable to the obstruction of the duct (see page 398) and the inflammation of the tissues, and partly by special examinations. The stone is rather impervious to the x-ray, and a good negative is probably the best way of locating or excluding small stones. For the positive diagnosis of small stones in the submaxillary or parotid gland, the x-ray may be absolutely necessary (Fig. 293). A probe of soft silver passed into the duct may locate a stone, and while there is no mistaking the

Fig. 293.—Calculus lying in Wharton's duct, shown in the radiogram as a light shadow in the submaxillary region, lingual to the mandible.

definite grating sensation which usually results from the probe sliding over the stone, the lack of this does not exclude stone; for the probe may not have passed as far as the stone, or the stone may be in a pocket. To us the most practical examination is by means of a strong hypodermic, used as an exploring needle. The examination is conducted as follows:

The most marked part of the induration, or its most tender point, is located by a bimanual examination. The surface over this is painted with a 10 per cent cocain solution. A hypodermic syringe with a strong needle is filled with a solution containing ½ per cent novocain and 1 per cent of the 1:1000 adrenalin chlorid solution. The needle is plunged into the suspected tissue, infiltrating as it progresses,

which, if done slowly, lessens the pain. Careful search, by repeated insertions of the needle, is made all along the suspected area, and when the stone is found, a fair idea of its size, or the size of a mass of stones, can be obtained in this way. By the time the examination is completed, the tissues are well anesthetized, and if it is a suitable case for removal under a local anesthetic, the operation can proceed without further preparation.

**Treatment.**—All stones and foreign bodies should be removed. For stones situated in the submaxillary duct or anywhere under the mucous membrane, this is usually not difficult. For a number of stones in the submaxillary gland, the latter may be excised; but a stone situated in the parotid gland, a rare occurrence, would present some serious considerations. A stone situated in Blandin's duct, in the parotid duct, in the sublingual gland, or in the submaxillary duct in front of the molar teeth can be removed with a local anesthetic; but a submaxillary stone situated behind the bicuspids, or in any situation in a nervous patient, had better be removed under a general anesthetic. A submaxillary duct stone having been located, it is pushed upward into the mouth by the fingers of an assistant placed under the jaw. A gag is placed in the mouth, and the cheek is retracted. With the forefinger of the left hand the operator attempts to steady the stone against the body of the jaw. An incision of some length is made down to the stone, and unless there is very profuse bleeding, no attempt is made to control it, since the work has to be done entirely by touch.

If the knife fails to touch the stone, it must be relocated with a needle. The freeing of a single stone is often not an easy matter. These stones frequently present uneven surfaces, and it is difficult to cut through strands of tissue which have gripped the stone in the little space between the nodules. For this purpose a small pointed tenetome is useful, cutting repeatedly with the point of the knife along the same line on the surface of the stone and at the same time attempting to work the tissues from the stone by lateral strokes of the point of the knife. If possible, the stone should be freed in this way until an elevator or small curette can be slipped under it. It is not good practice to undertake to grasp the stone with forceps thrust into the depth of the wound; for one is more liable than not to include some soft tissue in the bite, and it would be possible to do damage. The lingual nerve crosses beneath the duct from the external to the median side at the first or second molar tooth, but if one cuts straight

down on the stone and does not make grabs in the depth of the wound, it is in little danger of injury.

After removal of the stone, search should be made for possible neighbors. A nest of small stones is easier to remove than one large one. They can be scooped out of a comparatively small hole with a curette. The wound is packed lightly for a day or two, after which if all the stones have been removed, no further treatment than a mouth wash is needed.

A stone in the oral part of the parotid duct is treated in the same way. For a stone farther back in this duct, it seems to us that the best procedure would be to go down to it with a clean cut, remove the stone, and after passing a probe into the mouth to be sure that the duct is patent, suture the facial wound in its full depth. The danger here is that a salivary fistula might result.

A single stone, or several of them, could be removed from the parotid in the same manner as are tumor nodules, but if it were ever deemed necessary to remove the whole gland, it should be done piecemeal, after locating the trunk of the facial nerve and freeing its branches.

## WOUNDS OF THE SALIVARY GLANDS AND DUCTS

Wounds of the glands may be followed by an external flow of saliva, but this usually ceases spontaneously in some weeks.

Recent clean injuries should be sutured to their full depth and drained so that the deeper part of the wound cannot be distended. Infected wounds may have to be dressed open until clean enough to be sutured, and when this is done, intraoral drainage should be provided, if an external flow of saliva has persisted.

Lateral injuries of a duct will eventually heal without fistula unless there is considerable loss of substance. If the duct is cut completely through, the ends will retract, and the cut end of the distal part will eventually close. In recent injuries of the duct, an attempt may be made to suture the duct with fine catgut which does not penetrate the mucous lining. This is a difficult procedure. In suturing the duct, the proper approximation of the ends is more of an object than to make a water-tight joint. Whether or not the duct is sutured, free drainage, preferably into the mouth, should be made, and the tissues superficial to the duct should be accurately sutured. (See Treatment of Salivary Fistula, page 406.)

## SALIVARY FISTULA

A salivary fistula is an abnormal communication between a surface and a salivary duct or gland, through which saliva is discharged. These fistulae may be external or internal, but ordinarily internal fistulae are of no surgical interest, further than that their patency is necessary if there is an occlusion of the distal part of the duct. Rarely an external fistula of the submaxillary gland, or even of the duct, may result from a deep external wound, or an ulceration or abscess due to a stone, but practically all external salivary fistulae are of the parotid gland or its duct. Gland fistulae which commonly result from operations on the gland or from the rupture of abscesses are of less importance, both because they usually heal spontaneously and because the resulting symptoms are not as severe as those of duct fistulae. Duct fistulae most commonly come as a result of ill-placed incisions or from accidental wounds, but they may result from any ulcerative process—such as noma, gumma, or carcinoma. In gland fistula only a part of the secretion is lost, but in duct fistula the whole amount is apt to pour out on the cheek. Some general depression may result from the disinclination which the patient has toward eating, but the chief evil is the annoyance and embarrassment due to the presence of the abnormal flow. Between meals this flow is small; while taking food the quantity is considerable. Duphénix collected 70 grams from a patient in fifteen minutes, and Jobert had a patient who voided several cupfuls in twenty-four hours. Usually the mouth of the fistula presents a few granulations which may be surrounded by scar or normal skin, but in the duct fistula there may be a smooth union between the mucous lining and the skin. A recent fistula to a duct, which is still patent at its distal end, is likely to heal spontaneously or with a little help, such as local cauterization and pressure; but a fistula to a duct which is occluded or very much contracted, or a fistula in which the mucous lining of the duct has united directly to the skin, will close only after some successful radical operation. In reference to their repair, the location of the fistula and the amount of destruction in the distal part of the duct are of most importance—those situated in the buccal part of the duct being easily corrected, and those situated farther back having been considered more difficult of repair.

**Diagnosis.**—Except in the early stages of a fistula following an abscess, or of one occurring in a suppurating wound, where the saliva might be disguised by the pus, the diagnosis of the salivary fistula is

very simple. The discharge is perfectly clear, is increased during eating, and usually there is some irritation of the skin which is continuously wet with the discharge.

While a salivary fistula is usually recognizable at a glance or after a few questions, there are certain points which should be carefully determined. These are: the cause of the fistula; the exact site of the defect, whether of duct or gland; the extent of the injury to the duct; the distance between the skin opening and the duct injury; and the condition of the duct distal to the fistula. All of these bear upon the prognosis and treatment and can only be determined after certain examinations.

Simple fistulae leading to mucous-lined cavities or ducts in any part of the body have a distinct tendency to heal spontaneously, and unless the wall of the fistula is diseased, as with a tuberculous infection, unless the fluids within the duct or cavity can find an easy exit only through the fistula, or unless the mucous lining of the duct is united directly to the skin, the fistula will always close of itself. This is true of salivary fistulae, and the condition in relation to these points should be determined before treatment is begun. Specific ulcerations will need to be cured before any attempt can be made to close the fistula. A gland fistula can usually be recognized by its location, or, if it opens some distance from the gland, by its direction and the fact that only a small part of the whole secretion is discharged through it. The attachment of the mucous lining of the duct directly to the skin may sometimes be made out by inspection, or can be inferred if the fistula has no depth. The condition of the distal part of the duct and orifice can usually be determined by attempting to pass probes both from the fistula and through the orifice and by injecting methylene-blue solution into the fistula.

**Treatment.**—Many fistulae of recent origin will close spontaneously if absolute rest be given by intermaxillary fixation, and the patient put upon a milk diet. Most duct fistulae which have persisted for six months will demand some sort of radical treatment, but a gland fistula is usually cured by simpler methods. Usually repeated applications of silver nitrate or the electric cautery into the depth of a gland fistula and the application of pressure will bring about a cure.

Animal experimentation has shown that the tying of the excretory duct of a gland brings about an atrophy of its secreting cells, and it is possible that the inflammation and scarring, which result from the cautery, block the small ducts that lead into the fistula. If repeated

applications of the cautery, followed by pressure and restriction of diet to non-appetizing, unspiced fluids, fail to produce a cure, then the offending part of the gland must be excised, having first located and freed the branches of the facial nerve.

Duct fistulae are treated in several different ways, the choice depending upon both the location of the defect and the condition of the distal part of the duct. Very recent fistulae may be treated by cauterization of the outlet, and pressure or the application of impervious adhesive plaster. In cases where a permanent fistula is situated in the buccal part of the duct or near the anterior border of the masseter muscle, the external fistula may be converted into an internal one, or the proximal part of the duct may be implanted directly into the buccal mucous membrane. When the fistula is situated too far back, the duct can sometimes be repaired by suture, or by piecing out with a prolongation made from the buccal mucous membrane. After removing a section of the masseter muscle, and if necessary, part of the anterior border of the ramus, the end of the duct can be planted directly into the mucosa of the mouth.

**Conversion of an External into an Internal Fistula.**—There are two general plans for doing this: (1) the establishment of a new fistula by means of a seton; (2) passing a small drainage tube through the cheek at the site of the duct defect and gradually withdrawing it from the inner side, allowing the external fistula to heal, while the internal one remains patent. The latter is Kaufmann's method and is carried out as follows:

A trocar, 4 or 5 millimeters in diameter, is pushed through the cheek at the site of the fistula. It is very important, for success, that the trocar penetrate exactly at the site of the hole in the duct and that the deeper part of the external fistula is not separated from the new tract by a thin wall of tissue, which may effectually prevent the saliva finding its way into the mouth. A small spirally cut drainage tube is placed through the cannula, and the latter is withdrawn, leaving the tube in place. The tube may be treated in several different ways, one of which is to withdraw it toward the mouth until the external end disappears beneath the skin. The internal end is cut about 3 millimeters beyond the mucous surface, and then the patient is allowed to chew some food while the finger is pressed gently over the external opening. If the tube is properly placed, saliva should flow into the mouth. When it is determined that the saliva can reach the mouth, the end of the tube is made steady by grasping it and the mucous membrane gently with an artery forceps, and a retention

suture is passed through both and tied. The external opening is carefully dried and covered with a piece of adhesive plaster. As the stay suture cuts its way out, the drainage tube will be gradually forced out; but it should remain in place for two weeks, and if the external fistula is still open, it should be replaced if it comes out before that time. If, after a few days, the external orifice has not closed, it may be cauterized or freshened and sutured. If there is a depression at the site of the external opening surrounded by a scar, it will save time and give a better cosmetic result to at once excise this, undermine the skin, and draw it together by immediate suture. This operation can be done under a local anesthetic without detaining the patient from his business. Therefore, if the first attempt is not entirely successful, it should be immediately repeated.

Another way of establishing an internal fistula is to thread a strip of live rubber dam, 3 millimeters wide and 20 centimeters long, on a straight needle which is inserted to the bottom of the fistula and on through the cheek. This end being allowed to remain protruding into the mouth, the other end is threaded upon the needle, which is also inserted through the cheek from the bottom of the external fistula, but in such a manner that there will be about 1-centimeter space between the two points at which the dam pierces the buccal mucous membrane. The two ends of the dam strip are tied together with just a little tension, which will eventually cut through the intervening tissue. The dam should not be drawn tight as it is tied, for it would then cut through in a day or two and not stay in place long enough. If, after the fistula is well established, the seton does not cut its way out, it can be tightened by tying a ligature around the two internal ends between the knot and the mucous membrane.

The external opening is treated as in Kaufmann's operation.

**Reconstruction of the Distal Part of the Duct from the Buccal Mucosa.**—The idea of piecing out the duct with buccal mucous membrane was first presented by Nicoladoni and Braun. If the buccal mucosa is unscarred, it is very movable and can be used as follows:

The mucous membrane of the cheek with its submucous tissue is laid bare for some distance through a transverse incision in the external surface of the cheek. Two parallel transverse cuts are made in the buccal mucosa, 1½ centimeters apart. The central part of the flap thus outlined can be drawn for some distance back on the outer surface of the masseter. If the proximal end of the duct is long enough to be implanted into the end of this double fold, this is done, and the fold is held in its new position by two sutures, placed one

at each corner. By a running suture of catgut at the upper and lower borders, this double fold of mucus is converted into a tube. The new duct is buried as deeply as possible. If the duct is too short to be pieced out in this way, a tongue of mucous membrane with its base posterior is turned back and converted into a tube, into which the proximal end of the duct is sutured.

The secretion of saliva in a gland can be suppressed by ligating the duct, but this operation has been followed by such serious inflammatory reaction, due to infection, probably from bacteria that have already found their way into the ducts, that it is not to be recommended. As a final means, the parotid gland can be removed, but to do this completely and preserve the seventh nerve is a difficult procedure.

## TUMORS OF THE SALIVARY GLANDS

Tumors of the salivary glands are of extreme interest, both on account of the peculiar behavior of some and because, in spite of an immense amount of work that has been done on them, the exact nature of the largest group, the so-called "mixed tumor," is still a matter of dispute.

**Benign Tumors.**—Congenital enlargements of the sublingual and of Blandin's glands have been reported.

Lipomata, fibromata, angiomata, and lymphangiomata of the salivary glands have all been observed, but they are of rare occurrence. They present no special symptoms peculiar to this situation and are to be treated as are similar tumors in other situations, the operation being conducted in accord with the plans already outlined.

Obstruction cysts may occur within a salivary gland, due to the blocking of one of the smaller ducts, when the accumulation of secretion and epithelial detritus causes a cyst filled with a glary mucous-like fluid. This is a somewhat common occurrence in the sublingual gland, which constitutes one form of ranula, but is extremely rare in the other two. A cyst of this kind grows slowly. The symptoms and treatment of the sublingual cyst are described under ranula (see page 417). If obstruction occurs in a small duct leading from a lobule in the intraoral part of the submaxillary gland, this cyst would also constitute a ranula; but if the obstruction were somewhere in the body of the gland, it would bulge beneath the jaw.

For cysts bulging below the jaw or into the cheek, a removal of the whole or part of the gland might be necessary, as the simple opening of the cyst might be followed by a salivary fistula or a recurrence.

**Mixed Tumors.**—The more common and most important of the salivary gland tumors is the so-called "mixed tumor." It was formerly rather generally believed that these tumors were composed of a number of elements—fibrous and mucous tissue, cartilage, epithelial and endothelial cells—and this view is still held by many. Butlin, Kaufmann, Nasse, and Volkmann are of the opinion that all of the various substances which are found in them are the product of the activity of endothelial cells. Wilms, who has done some of the most important of the recent investigations, with many of the French workers, regards these mixed tumors as containing both epithelial and connective tissue elements. It is usually conceded that they often contain cartilage. Bland-Sutton classifies them with the sarcomata and calls them chondrifying tumors of the parotid.

Their histological contents may be remarkably diverse. Bland-Sutton refers to this as follows: "It is not unusual, in sections from parotid sarcoma, to meet with spindle cells, cartilage, myxomatous tissue, glandular acini, and fibrous tissue within an area of 2 centimeters square." Some are composed almost entirely of cartilage or a cartilage-like substance arranged in nodules bound together with loose connective tissue, and these represent the more slow-growing. The more rapidly growing tumors consist of masses of spindle cells in which the cartilage or cartilage-like substance may be interspersed. The tumors are liable to undergo mucoid or myxomatous changes, which result in softened spots or definite cysts.

These tumors may be congenital or may appear late in life, but they most often appear between the ages of fifteen and thirty years and have a peculiar preference for the right side. They are most common in the parotid, much less so in the submaxillary gland, and very rare in the sublingual. They occasionally occur in the lachrymal glands and palate. They may arise within the substance of the gland or may be connected with it by a stalk, but they are supposed to always arise within the gland capsule. Parotid tumors may arise in front of the gland in the cheek, in the line of the mouth slit (Fig. 294). Until they acquire or show a malignant character, they are encapsulated, and at this time, unless situated very deep in the parotid, are easily removed. The gland may be found compressed and wrapped around a large tumor. When not malignant, they are always sharply defined, but may be very nodular. At first they are usually firm, but later may be cystic. In the submaxillary gland they usually grow toward the neck, but in the parotid the direction of their growth will depend somewhat upon their original starting point.

A deep tumor may grow toward the pharynx. After malignancy once becomes evident, they infiltrate rapidly and may ulcerate through the skin. Death from the malignant mixed tumors, whether malignant from the first or whether the malignancy seems to be acquired later, results usually in a few months. Death results more frequently from the local disturbances—such as dyspnea, starvation, hemorrhage, or pneumonia—than from metastasis of the lungs and other organs.


Fig. 294.—Mixed tumor of parotid.

The most common clinical characteristic is the fact that for a long time after they are noticed they may grow slowly and then remain stationary for years, only to take on rapid and most malignant growth. With this sudden, rapid growth may come metastasis of the lungs and sometimes of the lymph nodes. A few grow slowly, but continuously, without any period of apparent rest. They are often the size of a nut or small orange, but may attain the size of a man's head. When these tumors have persisted for a long time, and es-

pecially in older people, they may become cystic. These cysts may reach an immense size. Hayes described one, of the submaxillary gland, that had existed for thirty years in a woman who died at the age of seventy-three, which was fifty inches in circumference, weighed forty-seven pounds, and which could have been easily shelled out. They may be tender in spots or may be painful, but are not necessarily so. When situated in the parotid, they often affect the seventh nerve. Salivation is sometimes a very prominent symptom.

The diagnosis of these tumors in their earlier stage is not easy, except on the supposition that a movable nodule situated within a salivary gland, not a lymph node, is probably a mixed tumor. With both the submaxillary and the parotid, tuberculous lymph nodes may for a time simulate a tumor; but these are usually multiple, and the behavior of the nodes will usually serve to distinguish them. Stone, which is much more common in the oral part of the submaxillary gland or its duct than in the parotid, is less easily defined than a tumor nodule and can be diagnosed by an exploring needle or the x-ray. After a tumor in a gland has grown slowly for months or years and then ceases to grow, the diagnosis is rather evident. If, later, this tumor takes on rapid growth, the diagnosis is almost certain. When used as a basis for diagnosis, the history must be taken with the greatest care. Even these tumors may sometimes be present for a long time before they are discovered. Tumors which are malignant from the first behave as do malignant tumors in other situations.

The prognosis of these tumors is good if they are removed while they are still encapsulated, even if they have already taken on rapid growth. Even the benign tumors may continue to grow after removal, for the reason either that their capsule was not completely excised or that some disconnected nodule may have been overlooked. A malignant recurrence after removal is usually of extreme virulency.

The treatment of all these tumors, unless on account of their extent and evident malignancy they are inoperable, is removal with capsule. If the tumor is surrounded by a capsule, it is not necessary to remove the gland, unless it is so nodular that there is doubt of including all of its prolongations. With tumors of the submaxillary gland, it is probably safest and simplest to remove the whole gland in every instance. With all but malignant tumors of the parotid gland, the seventh nerve must be preserved, which complicates the operation (see page 414). For malignant tumors of any gland, the whole gland with its capsule should be removed. If the structure has infiltrated the capsule, the neighboring structures should be removed

*en masse.* If this cannot be done, the tumor is inoperable. If the regional lymph nodes are found to be infected with the tumor, they should also be removed.

**Epithelial Tumors.**—Besides those mixed tumors in which the presence of epithelial proliferation is still a matter of doubt, three varieties of purely epithelial tumors have been observed.

Adenoma.—It is probable that many of the tumors which have been described under this head belong to the mixed tumor variety, but pure adenomata have been seen in all three of the salivary glands. They may be malignant.

Carcinoma.—The pure adenocarcinoma to which variety the malignant adenomata must belong, appear in two clinical forms in the salivary glands, both very rare. These are the medullary and the scirrhous carcinoma. They are both more common in the parotid than in the other glands, though it is possible that certain carcinomata of the floor of the mouth may have their origin in the sublingual gland.

Histologically a tumor of the salivary gland is to be considered an epithelioma when it is observed that it develops directly from the glandular epithelium, and that other elements of the mixed tumors are not present. The soft variety may originate in young persons and is characterized by the abundance of cell growth, later by ulceration. In the scirrhous variety, which occurs only in elderly persons, there is little tumor formation and marked retraction of the surrounding tissues. In this, it resembles scirrhus of the breast. The skin and tissues covering it may be drawn inward, and the surrounding skin may be thrown into folds. The soft tumors involve the lymph nodes more rapidly than does scirrhus, but with the latter a chain of small, hard nodes may be found extending to the clavicle. Pain is a rather constant characteristic of all carcinomata, usually more pronounced in the soft than in the hard variety.

In the parotid gland the seventh nerve is usually involved, but with the scirrhus the paralysis may be due simply to pressure. With the more advanced tumors, there is the usual picture of advanced carcinoma of the face or mouth with impairment of the function of all associated organs.

The diagnosis of carcinoma of the salivary glands in the early stages, when the diagnosis is a matter of the greatest importance, is practically impossible. If, after excluding syphilis, tubercle, and acute septic inflammations, all newly forming undiagnosed tumor masses are excised or subjected to a microscopical examination, their

diagnosis from clinical symptoms will be a matter of less importance. Many of the developing medullary carcinomata have been mistaken for a chronic or subacute inflammation. Carcinoma of branchial origin may simulate carcinoma of the submaxillary gland, but in the earlier stages this impression would be corrected at operation. Lymphosarcoma, developing within the parotid, might simulate medullary carcinoma.

The prognosis is bad. If, however, in the earlier stages the gland and its capsule are removed with the regional lymph nodes, a cure, or a long interval before recurrence, might be obtained.

The treatment is early excision of the whole gland, capsule, and involved tissue, *en bloc,* for a distance of 1½ or 2 centimeters, together with the regional lymph nodes. If this cannot be done, the patient should not be subjected to radical operation. When the odor and discharges are offensive, the ulcerating masses may be curetted, when not too close to large arteries, and packed with iodoform gauze saturated with balsam of Peru.

In complete extirpation of the parotid—if such an operation is ever complete—where the skin and fascia covering the gland are also removed, it is remarkable how little distortion of the face results. There is an inability to close the eye, but the scar contraction of the cheek seems to prevent the lateral displacement of the mouth that is typical of Bell's palsy.

## TUMORS AND CYSTS OF THE FLOOR OF THE MOUTH

### OBSTRUCTION CYSTS OF THE MUCOUS GLANDS

Retention cysts of the muciparous glands may be found on the inner surface of the lips and on the cheek along the line of occlusion where they may be caught between the teeth. Occasionally they are found along the edge of the upper surface of the tongue.

A more striking cyst is sometimes observed under the tip of the tongue due to the distention of a duct in the glands of Blandin. They may attain considerable size, are of the same bluish-gray color as other mucous cysts, and are to be treated by excision of the gland.

### RANULA

Ranula is a rather general term applied to chronic benign cysts of the floor of the mouth, due to obstruction of a duct or of a mucous or salivary gland. There has been much discussion as to the true

nature of the cyst. Nevertheless either the anatomical relations or histologic structures of the cysts that occur in the anterior part of the floor of the mouth would, it seems to us, limit the site of origin of a ranula to one of three structures: the incisive glands of Suzanne and Merkel, the sublingual salivary glands, or one of Bochdalek's glands.

Thompson, of Galveston, presents evidence also that many ranulae are of branchial origin, i.e., from non-obliteration of an embryonic cleft. Probably the most common misstatement made in regard to them is that they are due to obstruction of the submaxillary duct. This is denied by every careful observer, for Wharton's duct has always been found at least partially patent, when examined in the presence of typical ranula. Obstruction of this duct gives entirely different symptoms. It cannot be stated that a complete obstruction of the submaxillary duct could not cause a cyst in the floor of the mouth; but as the obstruction is then in the common excretory duct, the whole submaxillary gland shares in the distention, and cysts arising in the intraoral part of the submaxillary gland bulge downward toward the neck. Whether or not cysts of Blandin's glands are to be included under ranula is rather a matter of individual classification. The term has been commonly taken to mean a cyst in the floor of the mouth; and cysts of these apical glands are usually confined to the under surface of the tongue, and when the tongue is protruded, the cyst moves with it. If we define ranula as a cyst of the floor of the mouth, then a cyst of an apical gland will seldom come under this heading.

The rarest form of ranula is that which arises in the midline, just behind the incisor teeth, and is credited to the incisive glands. A ranula is much more commonly lateral in its origin, but as it grows, it crosses the midline and may be notched by the frenum. Certain ranulae are lined with ciliated epithelium, which in the mouth occurs only in the thyroglossal tract or its offshoots—as the glands of Bochdalek. That obstruction of an excretory duct of the sublingual gland is the most common origin of ranula is almost generally admitted. According to Baker, quoted by Butlin, it is accompanied by a secondary atrophy of the remainder of the gland and partial obstruction of the submaxillary duct by pressure. Morestin presents a dissection which shows the lobes of the sublingual gland extending through the mylohyoid muscle and appearing upon its under surface. This appears to be an explanation for certain ranulae that bulge

below the chin in a more marked manner than would result simply from pressure upon the upper surface of the mylohyoid muscle.

A ranula is usually unilocular, but there is no reason why it could not have a double origin.

**Symptoms.**—There is a chronic slow-growing swelling in the anterior part of the floor of the mouth, situated immediately beneath the mucous membrane, which may be median, or more on one side than the other. It is of a bluish-gray color, or may be reddish-gray from the number of small vessels that cover it. It is often covered by veins. It is tense and fluctuates, but does not pit on pressure. It

Fig. 295.—Ranula.

raises the tongue upward and, when large, may cause considerable inconvenience and discomfort, but it is not painful (Fig. 295). It rarely causes a prominence below the chin. If ranula develops in childhood, it may cause considerable protrusion and deformity of the lower jaw and displacement of the teeth. Rarely becoming infected, it causes extensive sloughing in the floor of the mouth. They occasionally rupture spontaneously, but the relief is only temporary, as the fistula closes and the sack refills. Rapidly developing cysts of the floor have been termed acute ranulae. Several have been reported which were due to acute obstruction of Wharton's duct, coming on while eating, in which there was a lateral swelling of con-

siderable size and also swelling of the submaxillary gland; in every instance it was very painful. We have seen one such case which was bilateral. If the sublingual bursa described by Tillaux really exists, this might account for some acute ranulae, in which case it would be a bursitis, but Butlin denies the existence of this bursa. An intermittent ranula may occur, due to a recurrent obstruction of a duct.

**Diagnosis.**—A lipoma in the floor of the mouth might be mistaken for ranula, as might an angioma; but on feeling it, a soft, solid, or readily collapsible, blood-vessel tumor could be distinguished from a cyst. Moreover, the appearance of these is usually different from ranula, but Monod has reported a dermoid in the midline under the tongue, which was of a bluish color, and apparently fluctuated.

Dermoids have a doughy feeling, and pit somewhat on pressure. Cysts of Wharton's duct are fusiform and are accompanied by swelling of the submaxillary gland.

**Treatment.**—Many small ranulae will disappear after opening freely and swabbing them out with carbolic acid or tincture of iodin, but, besides being uncertain of result, this cannot be considered good surgical practice. Though also uncertain of result, the passing of a seton of silk or twisted wire through the cyst and allowing it to stay until it falls out is not open to the more serious objections of the first method. Brophy uses a hollow fenestrated ring.

There are two other ways in which a ranula can be treated: complete excision; and the removal of all of its upper wall with the superimposed mucous membrane, and then suturing the cut mucous edge to the edge of the cyst wall. This latter operation should be done so that the floor of the cyst is completely exposed and there is no overhanging edge. It is best accomplished by making an opening into the cyst wall and getting a good hold upon the wall and mucous membrane with a Halsted artery forceps. Drawing the forceps upward, the wall and mucous covering are cut around with a pair of scissors, curved upon the flat. Care should be taken to wound neither the submaxillary ducts nor their opening. Hemorrhage is controlled partially with artery forceps, and completely by a continuous buttonhole suture of catgut, which fastens the mucous membrane to the edge of the cyst floor. This operation leaves part of the cyst wall to replace the normal mucous floor. We believe that it is good surgery to adopt this method with very large uncomplicated cysts, as excision of a large ranula is a serious operation. If not successful, the extirpation can be done later. Except in nervous

people this operation can be done under novocain-adrenalin injections. The cysts can almost always be excised from within the mouth, under either a local or general anesthetic; but it is to be remembered that a cyst of the sublingual gland will not shell out and will have to be cut from the remaining part of the gland. This operation is done by a free transverse, or horseshoe-shaped, incision of the mucous and submucous tissues in front or behind the openings of the submaxillary ducts, according to the location of the cyst. By blunt dissection, after the cyst wall is bared, the mucous and submucous tissue is pushed backward and forward until the upper surface and sides of the cysts are freed. If, for want of room, there seems to be danger of rupturing its wall, it may now be opened by a free incision, to the edge of which three forceps are attached. With a finger in the sac as a guide, it is freed by blunt dissection or by clipping with a pair of blunt-curved scissors. After removal, the sac should be examined, and if missing in any part, this should be sought and removed.

If the surgeon is doubtful of having removed all of the wall in any particular part, the edge of the mucous membrane should be sutured around the supposed situation of this piece of cyst wall; otherwise the cavity should be lightly packed with mildly antiseptic gauze for a few days, when a mouth wash will be all that is needed. Some large cysts might be more easily removed by an external incision, and if the cyst protrudes through the mylohyoid muscle, this is the only way it can be approached.

## DERMOID CYSTS

Though dermoids are always congenital, due to an inclusion of the epidermis within the tissues formed from the mesoderm, still they are rarely noticed at birth, and may not be evident until well past middle life. The great majority of them appear between the tenth and twenty-fifth years. They consist of a fibrous capsule lined with stratified epithelium, containing a mass that may vary in consistency from tooth paste to the yellow of a hard-boiled egg. They may contain hair or other skin appendages. Usually, as the result of ill-planned attempts at their destruction, the cavity may be an abscess communicating with the mouth or neck by a fistulous tract. As the suppuration never completely destroys the epithelial lining, the fistula persists and discharges intermittently. Dermoids, in relation to the floor of the mouth, occur in one or two situations: in the mid-

line beneath the skin or between the geniohyoglossi muscles; or laterally below the angle of the jaw. It is Butlin's opinion that laterally situated dermoids, which do not represent the remains of a branchial pouch, were once median and have shifted their position during development. It is possible that a dermoid occurring above the epiglottis may have originally had a more forward position (Fig. 296). Inclusion at the midline could occur only at the time of fusion of the mandibular tubercles.

The dermoid may attain such a size that the site at which it started to grow can no longer be determined. When small, they usually protrude downward below the chin, but may bulge upward into the mouth, in which case they appear as a yellowish mass beneath the mucous membrane. When very large, a dermoid may

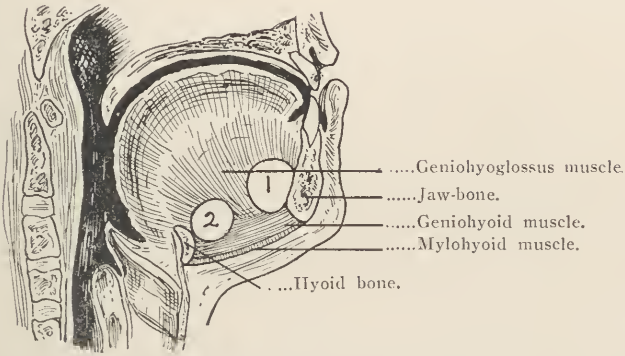



Fig. 296.—Diagram showing the locations of median dermoids in the floor of the mouth. (After Butlin.)

press the tongue upward and backward, and even cause dyspnea. They are to be distinguished from ranulae, which have a bluish or reddish-gray color, and when sufficiently large, ranulae give a distinct sense of fluctuation. On bimanual palpation dermoids yield a doughy sensation. They are of slow growth, usually requiring some years to attain any considerable size. In this they differ from most sarcomata, and they differ from all soft solid growths, including lipomata, in the doughy feeling that can usually be made out, and in the fact that unless very tense they pit on pressure. A dermoid, situated deep in the muscles near the hyoid bone, might be difficult to distinguish from a thyroid tumor or cyst in this situation (Fig. 296).

The treatment of dermoids is complete excision. If the mass is situated immediately beneath the mucous membrane, it can be re-

moved from within the mouth by a free incision and blunt dissection, but otherwise it is preferable to approach it from below. It is absolutely necessary to remove the whole of the epithelial wall. When approached externally, perfectly free access and a clear view of the tumor can be obtained. Further, the wound can be kept aseptic, the bleeding is easily controlled, and a properly placed skin incision will leave no perceptible scar.

## BENIGN TUMORS

Various benign tumors are to be excised. Those situated in, or immediately beneath, the mucous membrane of the floor are to be removed from within the mouth. More deeply situated tumors may be approached from the outside, as are dermoid cysts (page 419).

## MALIGNANT TUMORS

Sarcoma can occur in either of these situations, but the much more common tumor is carcinoma. In the floor of the mouth carcinoma may arise close to the tongue, in which case it has been supposed to be possibly a primary carcinoma of the sublingual gland, or it may be an extension from the tongue. Carcinoma may occur in the outer part of the floor as an extension from the jaw. In the cheek carcinoma may occur as an extension from the lip or jaw, or may arise independently. The latter, when on the mucous surface, are almost always of the indurating, ulcerating type.

# CHAPTER XXVI

## AFFECTIONS OF THE TONGUE

The tongue may be deformed congenitally or from accident, operation, or disease.

### CONGENITAL DEFORMITIES

These are very rare. The commonest is known as tongue-tie, and, popular belief to the contrary, this is unusual. It is due to a short frenum, which prevents the tongue from being protruded beyond the teeth or gums, and the effort to do so may cause the tip of the tongue to be notched. Children are often brought to the surgeon for tongue-tie because they do not talk, but this is rarely the real reason. A genuine tongue-tie may seriously interfere with sucking, and Makuen reports three rather marked cases of improvement in speech after releasing the tongue-tie. When tongue-tie is present, the frenum may be snipped with scissors close to the symphysis of the jaw, the tongue being elevated with the first and second fingers of the left hand. Only the tense part of the mucous band should be divided. Cutting too far back may injure a ranine vein; fatal hemorrhage has occurred from the child sucking on the bleeding vessel. Instances are also reported where a tongue that was made too free by the operation turned back into the pharynx, causing fatal asphyxia. Occasionally the tongue has been congenitally cleft in the midline. This may be accompanied by median cleft of the lower lip and jaw. This could be repaired by simply freshening the edges and suturing the two halves.

### FISSURES

Fissures on the surface of the tongue are often of extreme interest. A longitudinal fissure in the midline often suggests that the tongue is wide for its space. Irregular shallow fissures are often seen in tongues that have been the seat of inflammation. Fissures occur in acute infections, chronic superficial glossitis, tuberculosis, syphilis, and cancer; but according to Butlin, syphilis is the only disease that will produce deep fissures with permanent bosses and nodules between them. These are frequent in tongues that have been the seat of extensive gummatous infiltration and ulceration.

## ULCERS

"Simple" ulcers arise upon the tongue apparently from various causes. They are seen in all kinds of chronic superficial glossitis and sometimes in a scar. Occasionally they appear to be simply a melting away of the surface epithelium. The real reason why a simple ulcer occurs or why it persists is usually a matter of conjecture. The ulcer may become subacute or chronic, presenting a smooth, red, glazed surface with slightly callous edges. They may be irregular in shape with fissured borders. They may be very painful and sensitive, especially on taking irritating food or drink. The diagnosis of simple ulcer is usually easy from its indolent course and lack of induration. It may persist for many months with little change, but nevertheless all chronic ulcerations should be regarded with suspicion when present in persons who have reached the cancer age, and should not be allowed to persist indefinitely. If the diagnosis cannot be made otherwise, an examination should be made by a competent microscopist.

The response to treatment of these simple ulcers is often more or less disappointing. When due to chronic superficial glossitis, the plan recommended on page 426 should be adopted. The application daily of a 2 per cent solution of chromic acid or silver nitrate may stimulate epithelization. A very painful chronic ulcer could be incised or scraped in the hope of obtaining healthy active granulations, or, better, excised and the edges of the wound sutured. Any chronic ulcer that becomes the seat of increasing induration in one who has reached the cancer age should be regarded with grave suspicion. In simple, as in traumatic, ulcers the general condition should receive attention.

**Traumatic Ulcers.**—These may be precipitated by any kind of mechanical irritation, most commonly by a sharp jagged tooth, but traumatic ulcer is rarely entirely dependent upon the mechanical irritation. As pointed out by Paget, it seldom occurs when the patient is in good health, the tongue being normally very resistant to such irritations. At the onset the surface of the sore may be covered by a slough, the edges may be sharply cut, shreddy in places and eaten-out, and the surrounding tissues may be inflamed. In this stage it is really a phlegmon. In the more chronic stage, the swelling in the surrounding tissues is less marked, the edges are not so sharp, and the slough has disappeared from the base; but the induration of its base is more marked.

The diagnosis of simple traumatic ulcer may present difficulty.

The presence or history of an irritation will suggest the cause, but it is to be remembered that syphilis or tuberculosis may manifest itself at the site of a mechanical irritation and that cancer may arise in a chronic ulcer.

## INFLAMMATIONS

The mucous membrane may be the site of an acute catarrhal inflammation similar to that in other parts of the mouth. A small, acutely inflamed fissure or ulcer may appear near the tip, that is very painful. Or, possibly, a single filiform papilla will become inflamed and, rising above its fellows, will be subject to considerable irritation. Sometimes a very superficial abrasion or fissure will be surrounded by an extensive area of hard and somewhat tender induration, in which case it is no longer simply a superficial lesion, but a limited phlegmonous inflammation. These are collectively referred to by the patients as "canker sores" and are, we believe, to be distinguished from true aphthae. In many instances they are partly dependent upon some digestive derangement. The local application of a 2 per cent solution of nitrate of silver, or quickly touching them with a lunar caustic stick, and the use of a permanganate or alkaline antiseptic mouth wash will usually give relief. The bottom of a very painful fissure may be incised after applying a 10 per cent cocain solution, but the habit of cauterizing any mouth lesion deeply is to be condemned on account of the possibility of the scar predisposing to cancer.

## ERYTHEMA MIGRANS LINGUAE (GEOGRAPHICAL TONGUE)

This is a rare disease which appears almost exclusively upon the tongues of children and for the most part in subjects who are in poor condition. It starts as small, red patches, one or several, on the dorsum, usually near the tip. They appear smooth, as if the filiform papillae were absent, but in which the fungiform papillae stand out prominently. The patch spreads as a ring or oval with a sharply defined yellow border. When a ring reaches the border of the tongue, it continues around to the under surface. If two rings encounter each other, one may grow at the expense of the other, so that one ends abruptly while the other advances. The rings subside by contracting until they disappear, sometimes leaving the tongue slightly redder and smoother than normal.

Little is known of its cause. Syphilis, of course, has been put forward, but this is only a surmise. It usually causes so few subjective symptoms that its discovery is a matter of accident, but sometimes it causes an itchy sensation. It is very persistent and does not yield to local remedies. It may persist for months or years. One is at perfect liberty to try any local remedy which he may please, but none seems to have any particular effect. The general condition should be given particular attention, and all means possible used to build up the patient.

## CHRONIC SUPERFICIAL GLOSSITIS

The important characteristic of several forms of chronic superficial glossitis is a change of form and an arrangement of the epithelial cells, which may be collectively termed keratosis. It is this change in the epithelium that is of greatest interest, because it somewhat resembles the arrangement of the epithelium in the early stages of tongue cancer, and cancer is not an uncommon sequela. Keratosis appears in several clinical forms.

**Leucoplakia or Leucoma.**—This is a somewhat rare and extremely chronic disease that affects most commonly the dorsum of the tongue, but may appear on, or spread to, any part of the oral mucous membrane, or the red borders of the lips. It appears in two forms that differ in appearance, in clinical course, and in pathological anatomy. In the first of these the affected mucous membrane presents a smooth surface free from papillae, and is of a bluish color; the border of the patch may fade gradually into the surrounding normal mucous membrane or may be limited by a sharp line of demarcation. The surrounding mucous membrane may be normal or show evidences of irritations, and there may be red raw patches within the bluish-white area. The patch is often seamed with furrows, which may be sore and may later develop indurations of warty excrescences. The patch is usually somewhat pearly or opalescent and cannot be removed without leaving a raw surface. In this form a microscopical examination of the mucosa shows that the papillae have disappeared, leaving only a layer of corneous epithelium, which is thinner than normal. There is a proliferation of cells in the Malpighian layer, with a collection of leucocytes immediately beneath the epithelium, and the formation of some scar tissue. In other words, the patch appears to be scar tissue covered by a thin layer of epithelium.

The other form of leucoplakia is one that Butlin describes as less

common, but we have observed it more frequently than the former. It appears as an opaque, dead white, or slightly bluish or yellowish patch, which is usually raised above the surrounding mucous membrane, from which it is separated by a sharp line. It is thicker toward the middle than at the edges of the patch, and the outline is irregular, and often deeply indented. It may, both objectively and subjectively, feel dryer and harder than the normal mucous membrane. Later it is apt to become indurated and fissured, and the white covering may be cast off in places, leaving patches of red, raw tissue. In this variety of leucoplakia, in common with the one first described, the papillae have disappeared, and there are leucocytes and scar tissue beneath the epidermis; but here there is an immense thickening of the corneous layer which is the cause of the raised white appearance.

Opportunities for the study of the early stages of leucoplakia have been comparatively rare. The disease is then without symptoms and is usually discovered by accident. There is a condition designated by Butlin as smoker's patch, which is possibly one of the early forms of leucoplakia. It is a small, slightly raised oval patch situated upon the dorsum of the tongue, just where the stem of a pipe habitually rests or it is struck by a stream of smoke. The surface may be red and smooth and slightly depressed below the surrounding papillae. It later becomes covered with a yellowish-white or brownish crust that increases in thickness until it peels off, leaving the original smooth patch. In another form of smoker's patch, the surface is of a pearly bluish-white and perfectly smooth. In either case the disease has a tendency to spread. It may originally appear on the buccal mucous membrane opposite the space exposed between the teeth when the mouth is partially open. Smoker's patch may disappear on the removal of the irritation, may remain stationary for years, or, as is more common, it may spread indefinitely.

In persons who do not smoke, leucoplakia may first appear as a thin, bluish, filmy patch, and this may spread or retract, or even disappear; but after it has once become well-established, it probably seldom if ever is cured. In some cases the disease fluctuates, disappearing in one place, giving rise to the hope that it has been cured, only to break out in another. It may for a long time remain stationary, only to suddenly spread rapidly and involve possibly almost the whole of the oral mucous membrane.

Some patients are especially liable to attacks of inflammation in the patch, or it may die in places and, being cast off, leave a red,

raw, sore spot. Most of the real discomfort that these people suffer is in connection with these attacks of inflammation or excoriation.

Besides some special predisposition, the cause may be the local irritation of tobacco, strong spirits, high spices, hot foods, or mechanical irritation. The cause most generally assigned is syphilis, and although Gilmer states that he has never seen a case in a person who had not had syphilis, there are numerous other observers who report otherwise. We have seen a number of cases in which there was neither a syphilitic history nor other visible evidence of syphilis. Certain it is that, if syphilis is a cause, the leucoplakia is a post and not an active syphilitic manifestation. The disease is rarely seen in young persons and almost equally rarely in women, but it has been seen in women under twenty, in persons who do not smoke, in persons who do not use strong spirits, hot spices, or excessively hot foods, and in persons who are not syphilitics, so that no one of these can be looked upon as the specific factor.

The diagnosis of leucoplakia is to be made on the conditions described. It is to be differentiated from syphilitic mucous patches by the acute onset of the latter and the other signs of acute syphilis which may be present. Recent patches of leucoplakia are not so white and are not elevated. It is to be distinguished from postsyphilitic scars—Erb's scars, the thin, slightly depressed opalescent scars that may remain after secondary ulcers—by the history of the attack and by the unchanging size, shape, and character of the scar; from a syphilitic psoriasis by the presence of the same eruption on the skin and other manifestations of syphilis present; from lichen planus by the more pearly appearance and striated arrangement of the lichen and the presence of the eruption on the skin. Lichen yields to arsenic, administered internally, which is not the case with leucoplakia.

Leucoplakia patches may be present with psoriasis. Lissauer found such patches present in ten out of fifty cases of simple psoriasis.

The treatment of smoker's patch, leucoplakia, and smooth tongue is mostly palliative. Care in diet and limitation or abstinence from smoking, with elimination of other irritants, will do much to reduce the intensity and number of inflammatory attacks which cause the discomfort. In the quiescent stage no treatment other than abstinence from irritants is needed. Butlin allows a limited amount of smoking, but not chewing. In milder cases, a mouth wash of 15 grains of bicarbonate of potash, or 1 or 2 grains of chromic acid to the ounce of water, is recommended. The alkaline antiseptic solution

(N. F.), properly diluted, is always soothing to any form of irritation of a mucous membrane. Some tongues are benefited by a daily application of balsam of Peru. Butlin is partial to the application of ointments in all forms of irritation of the mouth and recommends some simple cerate, like cold cream or toilet lanolin. The surface is first dried with a soft cloth, and then a little ointment is applied and thoroughly rubbed in with the finger, or by rubbing the tongue against the roof of the mouth. In some cases one local remedy, and in others another, will be beneficial; but in no case should caustics be used, as the resulting scars might further increase the tendency to carcinoma. We have seen carcinoma develop simultaneously over the whole surface of a leucoplakia after such treatment. Constitutional remedies are of little avail. Even if a leucoplakia is dependent upon syphilis, it is a postsyphilitic lesion and is not influenced for good by mercury. It is the belief of some that it may even be caused by antisyphilitic treatment.

The question of excision will sometimes arise. This is not to be ordinarily recommended in early cases, unless they are very small. However, all persistent ulcers, thick indurations, and warty excrescences should be removed if possible. Small lesions can be excised, together with a wedge-shaped piece of tongue, which will allow the immediate coaptation of the edges by suture. If it were necessary to remove a large surface, the effort might be made to transplant a flap graft from the cheek to cover the defect. The disease is extremely chronic, and a radical cure probably rarely occurs except by incision.

## TUBERCULOSIS OF THE TONGUE

Tuberculous infections of the tongue may occur secondary to pulmonary tuberculosis, by direct contact from the sputum; it may be an extension of lupus from the face, or due to metastasis; and it is possible that in some cases the infection is primary. Ordinary tuberculous infection of the tongue is much more common in men than in women, but in the latter lupus is more prevalent. This is especially true of girls and young women.

Tubercles first appear as small yellowish nodules from 1 to 5 millimeters in diameter, and in this stage are usually discovered by accident. They seldom attain large size without ulcerating, but occasionally they may grow to be 1 centimeter in diameter, or larger, and still be covered with normal mucous membrane. They may be multiple, and most commonly appear near the tip or sides of the

tongue. If incised, they may show caseation. In place of frank ulceration, the nodule may become fissured.

**Tuberculous Fissures.**—These are usually single, short, and very deep compared with their surface extent. The sides are foul and ragged. The induration may cause an elevation of the edges, which has been described as a tuberculous papilloma.

**Tuberculous Ulcers.**—Lupus is usually associated with the same disease on the face. It shows more tendency to shrink and atrophy than to break down, and small tubercles can usually be found in and near its edges. It gives rise to a purulent discharge, but shows no tendency to slough *en masse* or to form punched-out ulcers. It gives little pain and is very chronic. Tuberculous ulcer is the term applied to the more aggressive type. A tuberculous ulcer may arise in a tuberculous nodule, in a traumatic ulceration, or may start without a recognized previous induration or injury. When completely formed and not sloughing too extensively, it usually shows an uneven, pale, flabby surface or rather watery granulations, or covered with a grayish-yellow secretion. The edges may be slightly redder than the surrounding mucous membrane. They are usually sharp cut or beveled, rarely elevated, everted, or undermined, but Butlin states that he has seen tuberculous ulcers with as much induration as is found in carcinoma. At first the ulcer may be indolent and neither painful nor tender; but as the disease advances, tenderness and pain become marked, and the patient declines from both exhaustion and lack of food.

The ulcer later advances rapidly with or without actual sloughing, and if unchecked, death usually takes place within a few months. If the ulcer should heal spontaneously, as it may do in the early stages, it usually returns later to the same spot.

**Treatment.**—The local treatment of a tuberculous infection of the mouth will vary with the character of the lesion, its location, and the general condition of the patient. Lupus anywhere is to be treated with such milder measures as the Finsen light, curetting, the application of lactic acid, or the x-ray. Tuberculous nodules and small ulcers are to be excised, and the defect closed by immediate suture. In the roof of the mouth and upper jaw, larger ulcers may be scraped, and the surface repeatedly painted with lactic acid. On the tongue, or the floor of the mouth or lower jaw, the ordinary tuberculous infection is in the majority of cases as fatal as cancer, and it should be treated accordingly. A possible exception to this may be made in patients with pulmonary or general tuberculosis, and such

patients can be made much more comfortable. The general treatment should be the same as in any tuberculous infection, and one of the first things gained by excision is freedom from pain, rest, and ability to take food. Specific vaccines may be employed by those familiar with the methods. As in cancer, the favorite treatment of tuberculosis at present is the use of the actual cautery. Hygienic treatment should not be overlooked.

## SYPHILIS OF THE TONGUE

Syphilis is one of the most frequent diseases of the tongue and next to cancer the most important; yet this does not warrant the very common assumption that every obscure affection is due to syphilis.

**Chancre.**—The primary sore may occur upon the tongue, but not nearly so frequently as it does upon the lips; it is much more frequent in men than in women. In every case there is an early and marked enlargement of the cervical nodes, usually of both sides, but the enlargement is not always greatest on the side corresponding to the sore.

**Mucous Patch.**—These may occur on the dorsum or under surface, but more frequently on the sides and tip. They are not so common on the tongue as on the lip and tonsil. They are usually multiple, are more common in men, and rarely appear without other signs of secondary syphilis.

**Syphilitic Fissures.**—These may occur in the secondary or the tertiary stage. The former are almost always on the border of the tongue, due to irritation of the teeth. They may occur in a mucous patch, in which case the fissure may be stellate and will show sloughy borders, or they may develop without a previous mucous patch. These latter will show little evidence of inflammation, but are tender and painful. These fissures may extend and become ulcers. Often there is nothing in their appearance to denote their specific cause. After removal of irritants—such as rough teeth—they heal quickly under antisyphilitic treatment and the daily local application of a 2 per cent solution of chromic acid; but they leave scars, which may be depressed or may be raised and show milk-white lines or patches. The fissures of tertiary syphilis are probably fissures in gummata, although they may show little induration. They are usually situated in the dorsum and may be very deep. The treatment is the

same as for gummata, but the depth of the fissures should be kept free from food and filth. They leave deep fissured scars.

**Sclerosing Glossitis—Tertiary Plaques.**—Under this head Butlin describes a condition, to which attention was first pointed by Fournier, and which, according to the latter author, is often responsible for the deep fissures that are seen in old disfigured tongues. Butlin describes a case under his care at St. Bartholomew's Hospital, which, during the course of a severe tertiary syphilis, showed plaques on the tongue on several occasions. One on the middle of the dorsum he describes as being an inch long, made up of two separate oval plaques, which afterward coalesced and, increasing considerably in size, formed a single plaque measuring two inches long and three-fourths of an inch across. It rose almost abruptly from the dorsum and in its center reached the height of one eighth of an inch, but was a little less elevated at the sides. It was perfectly smooth and of a deep-red color, but with a decidedly purple tint. Down the center ran a groove formed by the meeting of the two original plaques. The whole plaque was glazed and shiny, and was at no point broken or even cracked. It felt very firm, but the firmness did not extend far into the substance of the tongue. In other somewhat similar plaques which had previously appeared on the same tongue when the patient neglected treatment, there developed a moderately deep ulceration, but all would disappear under proper treatment.

According to Fournier, there may be a superficial or deep sclerosing glossitis, depending upon the depth of the induration. In the superficial variety there are indurations which develop in the derma, and which feel like discs of parchment. They are of a deeper red than the surrounding mucous membrane and may be of any size and shape. They tend to break down, forming fissures or ulcers which, when healed, leave milk-white patches. The disease is very chronic and very painful in the ulcerated stage. In the deeper variety there may be no induration of the superficial part of the mucous membrane. The surface of the mucous membrane is mammillated or lobulated, and like the surface of the liver in cirrhosis, ulceration is liable to result, especially in the fissures. A rare form is the syphilitic macroglossia, in which the whole tongue is swollen and hardened. There is not, we believe, evidence to show that these various forms are not due to diffuse gummata, and they are often accompanied by ordinary gummata.

The prognosis of the lesion will depend upon its extent and the time at which treatment was begun. After scar is formed, the de-

formity is permanent, and the resulting fissures may be the source of constant irritation.

**Gumma.**—Gumma of the tongue may be superficial or deep. In either situation they are apt to be multiple, but the deep gummata are often larger and may persist longer without ulceration.

## TUMORS OF THE TONGUE

### LYMPHANGIOMATOUS MACROGLOSSIA

**Lymphangiomata** appear in the mouth, as either grouped or scattered vesicles, which usually contain clear fluid, or which may be hemorrhagic from the rupture of a capillary. Between the vesicles are seen bright-red points due to capillary loops. A patch of vesicles may be small or cover a considerable area. The vesicles may be so small as to require a hand-glass for their detection. We have seen them on the under surface of the tongue as several discrete tufts that resembled papillomata in which no vesicles could be seen.

They start as simple dilatations of the lymph spaces beneath the epithelium. But as these extend, the surface epithelium is thinned; by extending downward and by fusion of the spaces, large cysts may be formed. In the tongue the growth of lymphangiomata with their various subsequent changes constitutes lymphangiomatous macroglossia.

Lymphangiomata are usually congenital, but may not show active enlargement until puberty or later. They are apparently not always congenital, for they have followed injury or operations upon the tongue or mouth, even so slight as the cutting of the frenum. The enlargement of the tongue, though progressive, is from time to time accentuated by the acute attacks of inflammation. At first the tongue may simply present vesicles on some part of its surface while its substance is soft. When the vesicles rupture, they may leave tender places that cause a disinclination to take food. Later, as the size increases, the tongue can still be retained within the mouth, but it is evidently too large. It causes impairment of speech and difficulty in eating. When it constantly protrudes, the saliva dribbles, the teeth become coated with tartar, and the mouth is foul. The tongue is subject to attacks of superficial glossitis with ulceration, and becomes dry and fissured. The teeth become displaced, and the palate and jaws deformed. When the enlargement occurs during the period of growth of the bones, the deformity of these is much more

marked. The whole tongue may be the seat of the angioma, but more commonly it is limited to some part. Aside from the swelling that follows acute inflammatory attacks, the process is slow of development, requiring months or years to reach an advanced form.

**Treatment.**—This should be excision of the affected area made through healthy tissue. When the disease involves the whole tongue, there is little question that a total excision should be made, for it is progressive and will continue to grow unless removed. If so radical a measure does not seem advisable, a wedge-shaped excision should be made of sufficient tissue to allow the tongue to be retained in the mouth.

## TUMORS OF THE BLOOD VESSELS

Aneurysm, in its various forms, may occur. Capillary nevi, similar to those seen upon the skin, composed of a mass of dilated capillaries, occur on the tongue, cheeks, and lips. They are usually congenital, but may be acquired. Upon the tongue they appear as small, slightly elevated patches, the size of a pea or smaller; on the buccal surface of the cheek they may be larger—here, or upon the lip, they may be continuous with a wine spot upon the face. They are of a bluish color, darker than their surroundings, and at the periphery an interlacing of small vessels is visible. They may be single or multiple or may converge into the venous cavernous form of angioma.

**Cavernous Angioma.**—The venous or cavernous angioma is composed of a mass of dilated veins and is either sharply circumscribed or merges into the capillary form. The circumscribed cavernous angioma possesses a distinct efferent artery and afferent veins and does not communicate with the neighboring capillaries. They occur singly or in groups and show lumps or ridges of distended veins, of a dark bluish or greenish-black color, which project slightly above the surface and may extend deeply into the subjacent tissues. They are very compressible, but immediately refill when pressure is released. When the head is held low or pressure is put upon the deep jugular veins, or when anything else occurs that retards the venous return, they become more distended than usual. They are usually congenital in origin, often growing later from capillary nevi, but they may arise apparently independently of a congenital angioma.

Venous and capillary angiomata are of clinical importance, both because of their liability to hemorrhage and because they may spread indefinitely, converting all tissues of a large area into a swollen, discolored mass of thinly covered blood vessels. In the tongue they are

usually not large, though there are a few instances on record in which the whole tongue was converted into a greatly enlarged cavernous mass. Parts of the lips, cheeks, and floor of the mouth and face may be converted into a soft, compressible tumor of a bluish color on its mucous surface and slightly more reddish on the external. Nowhere are these extensive extending nevi sharply marked off from the surrounding tissue. When situated under the tongue in the floor of the mouth, cavernous angioma has been mistaken for ranula. Besides being the source of occasional copious hemorrhages, started by injury or by simple rupture of the thin-walled vessels, these nevi may become infected and suppurate. In the smaller tumors, especially of the capillary nevi, this may be followed by obliteration, but in the more extensive cavernous ones it constitutes a serious complication. Cavernous nevi are sometimes obliterated by fatty degeneration.

The diagnosis of capillary and venous nevi is usually extremely simple, but if indurated, it is desirable to determine whether the induration is due to some former injury or infection, or to the involvement of the lymphatics. The latter condition would constitute lymphangioma. In pure hemangiomata indurations due to past injury or infection are usually sharply localized, while the inflammation that often accompanies lymphatic dilatation causes a more diffuse hardness. With the lymphatic angiomata, the characteristic blebs are usually present.

**Treatment.**—As a general proposition, all angiomata should be destroyed or removed. While small nevi, as such, really need no treatment; still, when small, their removal is a very simple matter, and their tendency to enlarge at any time must not be ignored. At least, they should be destroyed or removed as soon as they begin to extend. Many blood vessel tumors have been destroyed by the injection of irritating substances into them, but with the exception of boiling water in the large diffuse cavernous angiomata, the injection treatment is to be condemned on account of the danger of both sloughing and embolism. Besides the injection of boiling water into certain selected cavernous tumors, there are three lines of treatment that may come within the domain of good surgical practice: (A) the ligation of vessels; (B) the destruction of the mass by acupuncture; and (C) the excision of the mass, either by dissecting it out or by cutting through the surrounding healthy tissue. Other things being equal, excision is the best practice.

Small, and even large, nevi have been destroyed by the electric needle.

## CARTILAGINOUS TUMORS

Cartilaginous tumors, or cartilage-like tumors, may occasionally arise in the tongue in connection with the median septum, or secondly in the endotheliomata. They are exceedingly rare. The osseous and the true cartilaginous tumors are congenital and can occur only in, or near, the median line, and are of extremely slow growth. Endotheliomata that produce a cartilage-like substance are also of slow growth, but like mixed tumors of the salivary glands they may become active. They should be removed if they cause symptoms or show any activity, but it is more probable that they will be removed to make sure of their character.

## LIPOMA

Besides those that occur in or under the tongue in the midline and which grow into the floor of the mouth, lipomata have been reported as occurring singly at the anterior part of the border of the tongue; and multiple lipomata of the tongue have been observed in old men. Except those that occur in the midline beneath the tongue, the tumors lie immediately under the mucous membrane, which, although thinned and stretched and devoid of papillae, is movable over the growth. Usually the yellow color has been apparent through the thin mucous membrane. The superficial tumors are movable, can be displaced by finger pressure, and their lobulated structure is palpable. The central lipomata are probably always congenital and derived from the median septum of the tongue. They are likely to contain both fibrous tissue and cartilage. These may grow between the muscles until they appear beneath the chin. These tumors seldom cause ulceration, and even when as large as a small orange, they are remarkably free from subjective symptoms. Excepting those which are congenital, they have usually appeared in middle or later life. They are to be distinguished from soft sarcomata chiefly by their chronicity, requiring as they do many years to attain any considerable size.

The treatment of lipomata that have attained a sufficient size to attract the patient's attention is removal.

## FIBROMA

These occur in two forms: the soft tumors that are especially liable to become pedunculated and are often known as lingual polypi, and the hard tumors that are more apt to remain intramuscular. The

former are frequently situated on the dorsum of the tongue and are often multiple. It is stated that they are apt to follow a chronic inflammation as do polypi of the nose. These soft tumors grow slightly more rapidly than do lipomata and do not possess their yellow color, but otherwise resemble them closely. The hard tumors are much rarer than the soft. Neither variety gives subjective symptoms, except those due to their size. The treatment is the same as of lipoma.

## TUMORS AND CYSTS OF THE THYROGLOSSAL TRACT (LINGUAL GOITER)

The demonstration by His of a tract of tissue extending from the pyramidal lobe of the thyroid gland to the foramen cecum has made possible the explanation of tumors and cysts occurring near the foramen cecum or the hyoid bone, that contain elements belonging to the thyroid gland.

**Thyroglossal Tract Tumors Near the Foramen Cecum.**—These may be cystic or very soft solid. All of these tumors are of congenital origin, but they may not develop sufficiently to cause symptoms until later in life. Usually they are noticed about puberty, but may not give symptoms until late in life. Those occurring about the foramen cecum are usually somewhat sessile and vary in size from a pea to a hen's egg. When large, they project backward toward the pharynx and forward to a less extent, though another tumor may occur above the hyoid that projects beneath the chin.

They are usually of a dark color, covered with stratified epithelium and large veins. They are enclosed in a distinct capsule, and their substance shows mature or immature typical thyroid gland tissue. Where cysts occur, they are lined by ciliated epithelium. The tumors are very vascular and may contain hemorrhages. Occasionally they are so vascular as to be described as blood cysts. Besides the disturbances that are dependent upon the size and location of the tumor, the most constant symptom is hemorrhage into the mouth, due to rupture of the veins that almost invariably cover it. It occurs most commonly in girls and women. The diagnosis is to be made on: the location of the tumor; its slow growth, usually having been noticed for several years, or hemorrhages having occurred over this period; and its dark color, as seen with the laryngoscope. The lack of surrounding induration or ulceration serves to distinguish it from a malignant growth. Owing to its vascularity, it is not practicable to obtain a section for microscopical examination. In examining tumors and cysts situated

along the line of the thyroglossal tract, the situation of the thyroid gland should always be carefully palpated to determine the presence of the normal gland.

Cases have been described in which the lingual tumor was the only thyroid substance present, and its removal was followed by myxedema.

**Perihyoid Thyroid Tumors and Cysts.**—Besides the thyroid gland substance that occurs along the tract within the substance of the tongue, aberrant thyroids have been found in and about the hyoid bone.

Thyroid tumors and cysts occurring above the hyoid tend to project externally between the chin and hyoid bone, or upward and backward, pushing the base of the tongue before them, or they may separate the muscular layers in the midline and project under the mucous membrane of the dorsum of the tongue. They can usually be observed and felt from without, and if deeply situated, can be felt by bimanual palpation. They may be cystic or solid and may cause symptoms varying from slight difficulty of speech to suffocation. If they come to lie immediately beneath the mucous membrane of the dorsum of the tongue, they may cause hemorrhages, similar to those that occur with thyroid tumors originating near the foramen cecum.

Those tumors or cysts that lie below the hyoid are usually attached to its lower border or posterior surface. Cysts often extend up between the bone and the thyrohyoid ligament. The latter ligament is attached near the superior border of the bone, with a rather inaccessible space between the membrane and the posterior surface of the bone. Cysts attached in this space have often been difficult to cure. They are liable to become infected from such ill-advised treatment as puncture and injection, and sinuses remain that lead up behind the bone. These sinuses intermittently discharge a glary fluid, or, becoming obstructed, bulge with the contained fluid. When the cavity is infected, the accumulation is accompanied by acute inflammatory symptoms. Unless all of the epithelium is removed, recurrence will take place.

**Treatment of Thyroglossal Tract Tumors and Cysts.**—Tumors situated near the foramen cecum, which have persisted for some time and are not increasing in size, and which cause neither subjective symptoms nor hemorrhage, have been considered to require no treatment, as they have never been known to become malignant. When treatment becomes necessary, it should be excision. Owing to the vascularity and inaccessibility of the growths, the galvanocautery or hot snare is almost universally recommended for the removal of all

but very large growths; and when used, the cautery should be at a dull heat to prevent bleeding.

The treatment of tumors, cysts, or sinuses is by excision through a median incision, but it is absolutely necessary that the retrohyoid, or even intrahyoid, part be removed. We have seen a number of cases

Fig. 297.—Scars resulting from repeated inflammation, and incomplete operations on a thyroglossal duct fistula.

Fig. 298.—The external opening of a thyroglossal fistula in a child eleven years old. Removed completely without difficulty, after dividing the hyoid bone.

of sinuses in this region that had been repeatedly incompletely removed, or had been cauterized, but not one of them was permanently cured by this treatment (Fig. 297). The simplest way of reaching the retrohyoid attachment is by cutting the bone in two or removing a section of the body. It has not been found that dividing the hyoid causes subsequent trouble, if the halves are sutured by their facial coverings or if a section of the body is removed (Fig. 298). If a sec-

tion is removed from the body, sufficient bone must be retained to preserve at least part of the attachment of the geniohyoid and genio-hyoglossi muscles.

## PAPILLOMATA, WARTS

These are local epithelial proliferations that grow toward the surface and remain superficial to the basement membrane. This distinguishes them from malignant epithelioma—cancer—in which the multiplying cells break through the basement membrane and invade the deeper tissues. They are not uncommon in the mouth, occurring upon the dorsum of the tongue, although they may grow on the under surface of the tongue, on the lips, or on the inner surface of the cheeks. They are usually single, but may be multiple. They may occur at any age, but are of much greater surgical interest in persons who have reached what is regarded as the cancer age. This is especially true of warts that develop in a patch of leucoplakia or chronic superficial glossitis, as, according to Butlin, these almost invariably become cancerous, if not so from the first. Papillomata within the mouth resemble warts in other parts of the body, but on the lip, as already mentioned, they may develop true horn. When developing within a patch of leucoplakia, they at first look like a localized thickening in the patch, but later their watery character becomes apparent. Condylomata and mucous patches in protected areas—such as under the tongue—may resemble a soft wart, but their recent growth and other signs of syphilis will usually give a hint as to their character.

**Treatment.**—Considering the fact that these growths are closely related to cancer and within the mouth in older persons are often but an early manifestation of cancer, we believe that there can be no mistake in the position that they should be removed. There are many ways of removing or destroying a wart, but the most certain is the removal of its base by a wedge-shaped excision; and if followed by immediate suture, primary union will occur. In this way the complete removal is assured, and the postoperative discomfort is reduced to a minimum, as is the amount of resulting scar tissue; and the growth is preserved for examination.

## SARCOMA

This is one of the rarest of tumors of the tongue. But a few have been reported in literature, and of a number of these, description of the microscopical appearance and the clinical behavior have led to a

doubt or a negation of their sarcomatous nature. Of the true sarcomata, most have been of small, round cell type, some with considerable fibrous tissue. Some of these small, round cell growths have been supposed to be lymphosarcomata developing from lymphangiomata. There is nothing characteristic about their location or mode of origin, and among those reported, several have appeared early, but grown intermittently, remaining stationary for years, only to terminate in extreme malignancy. Von Bergmann states that even in the earlier stages they are always very painful. This does not correspond with sarcomata in other regions, where they are usually not painful. Some ulcerate early, while others reach considerable size without involvement of the mucous membrane. When ulceration is excessive, the growth might be taken for gumma or carcinoma. Some have caused enlargement of the regional lymph nodes, while others have not.

Those sarcomata that cause a real involvement of the lymph nodes are probably of the lymphatic type. The malignancy of the growths varies excessively, and their histological character seems to furnish little light on the prognosis. Rapidly growing, small, round cell sarcomata have been removed from the tongue, with no return for years afterward; yet, in as many reported cases, the growth has returned repeatedly, both locally and in the lymph nodes, after short periods, in spite of extensive operations.

The diagnosis of sarcoma, in order to be of use to the patient, must be made microscopically; the specimen removed for this purpose should include the edge of the growth and a portion of the surrounding tissue. Between hypertrophy of the lingual tonsil and lymphosarcoma the microscope may fail to distinguish. Tumors growing in the neighborhood of the foramen cecum should not be incised with impunity, as the aberrant thyroid growths are extremely vascular and might give rise to troublesome hemorrhage. After removing a piece of any growth for microscopical examination, the raw surface should be immediately cauterized to control hemorrhage and prevent distant transplantation.

**Treatment.**—The diagnosis having been established, the treatment is, of course, removal, with a wide sweep into the healthy tissue. If the lymph nodes are enlarged, these should be removed if, upon microscopical examination, the enlargement proves to be due to infection with the growth. It is questionable if more extensive operating is indicated than is necessary to remove the evident growth with a fair margin of the healthy tissue, for some sarcomata have remained

cured for years after being removed with a very meager amount of healthy tissue, while others have returned after repeated extensive operations. The result depends so much upon the degree of malignancy of the tumor that, provided the incision is carried beyond the apparent limits of the growth, the character of the operation seems to have little influence on the outcome.

**Carcinoma** of the tongue is dealt with in the chapter on Tumors of the Mouth and Jawbones. (See page 288.)

# CHAPTER XXVII

# DISEASES AND TUMORS OF THE LIP

Congenital clefts of the lips and palate were described in Chap. XXI.

## INJURIES

Bruises of the lip may cause great swelling, but as a rule need no special treatment. If seen early, ice may be applied. The lips may be deeply cut, usually from blows which drive the lip against the teeth. The cut may be entirely through the lip, or it may be only on its inner surface. In either case, the coronary artery may be cut. Wide cuts, or cuts that extend entirely through the lip, should be immediately and accurately sutured, but the sutures should not be drawn very tight, as swelling will occur. Usually the sutures will control the bleeding. If there is much sloughing tissue, this may be trimmed with scissors. A slight purulent discharge from the surface of the wound does not preclude immediate suture, but if there is much inflammation of the surrounding tissue, suture is to be postponed until this subsides.

## SCARS

The lips may show scars from various causes, the most interesting of which are fine radiating scars observed most commonly about the angles of the mouth, and which extend to the buccal surface. These are due to a former syphilitic infiltration and are to be differentiated from perlèche.

Deforming scars are to be excised and repaired according to the principles already given (Fig. 299).

## LIP CRACKS OR CHAPS

These are common and often annoying. They occur most commonly either at the corners of the mouth, or in the middle of the mucous surface. Persistent cracks or ulceration in the corners of children's mouths, becoming infected, may lead to lymphatic hypertrophy of the lip. Chronic cracks or ulcers at the corners of the

mouth in children are sometimes due to syphilis. Simple cracks or chaps occur usually in winter, and in some persons they are recurrent and annoying; especially a crack that comes in the middle of the lower lip, being slightly indurated, with every movement of the lip tends to become deeper. It bleeds occasionally and persists throughout the winter. It seems to be dependent upon the anatomical configuration of the lip, and persists on account of the induration of its edges and the mobility of the lip. If the two borders can be strapped together with an adhesive plaster for a week or so, it will heal; but this is difficult to do, and the remaining depression is very liable to

Fig. 299.—Deformity of the lower lip, due to scar resulting from noma.

open again. In the marked cases it is advisable to excise the fissure with a knife and approximate the borders with deep sutures. This may be followed by permanent relief. Lesser fissures are to be treated by the application of some rather stiff lip salve, to which an antiseptic may be added in appropriate cases.

## SIMPLE HYPERTROPHY

Either lip may be enlarged from the habit of lip-sucking. Permanent simple enlargement of either lip often persists to an annoying extent after malocclusions have been corrected.

## MACROCHEILIA (ENLARGEMENT OF THE LIP)

Macrocheilia may be due to a chronic lymphangitis, and is usually dependent upon a chronic inflammation of fissures, eczema, etc. It usually occurs in sickly children. When such a condition is noticed, great care should be taken to cure or prevent fissure, eczema, etc., of

the lips. Chronic enlargement of the lip in an adult may be due to syphilis, and in infants, syphilis may cause a diffuse infiltration of the borders. If sufficiently pronounced to demand correction, it can be done by excising a wedge-shaped portion which will resemble a section from an orange. The long axis of the base of this wedge is parallel with the mouth slit. The base of the wedge is to be at the junction of the edge of the lip with its oral surface, and the edge of the wedge is to be taken from deep in the lip, with a razor-edged knife. Before doing this, both ends of the lower coronary artery should be, at least temporarily, controlled. A less accurate correction can be made by simply removing a wedge from the central part of the lip, that includes an equal amount of the mucous and cutaneous surfaces.

## FURUNCLE

Furuncle or carbuncle of the lips and face is of special interest because of the relative frequency with which it has been followed by thrombosis of the cavernous sinus of the dura mater. The explanation given for this is that the facial vein communicates freely with the ophthalmic and that neither contains valves.

## PHLEGMON

Phlegmon may develop in the lips, and this is sometimes seen after the bites or stings of insects. There is always considerable edema. Ice is to be applied in the early stage, and an incision is to be made as soon as pus is located.

## GANGRENE

Gangrene of the lips is almost always due to cancrum oris (see page 197).

## HERPES

Herpes of the lips is common. On the lips the vesicles rupture and dry, leaving a yellow-brown crust.

## PERLÉCHE

Perléche is a superficial ulceration, limited to the angles of the mouth, which appears in children of school age, and is of interest chiefly because it has to be distinguished from syphilis. There is

roughness of the skin at the angles, which is marked by numerous radiating grooves. The skin of the area is somewhat brownish in color, and sometimes moist fissures appear at the corners. There is a burning sensation which leads the children to lick the patches, whence the name. By most observers it is believed to be due to an infection. Lemaistre believes it to be due to an aerobic streptococcus. The treatment consists in the application of tincture of iodin, or a drying powder. It is to be distinguished from syphilis by its localization, the fact that the radiating grooves do not extend to the mucous surface of the cheek, and that in healing it leaves no scar.

## TUBERCULOSIS OF THE LIPS

Lupus may occur on the lip in conjunction with lupus of other parts of the face. Ordinary tuberculosis ulcer occurs but rarely on the lip.

## SYPHILIS

The lip is a common site for extragenital chancre, which does not, as does the genital chancre, show a characteristic size and appearance, but does always at some stage show an indurated base. It may vary in size from a dime to a dollar and is usually ulcerated. The ulceration may be evident or hidden by thick crusted scabs. It is differentiated from carcinoma by its acute onset, its spontaneous recovery at the end of five or six weeks, the early and marked enlargement of the lymph nodes, its disappearance under antisyphilitic treatment, and the presence of *Spirocheta pallida.* Mucous patches are very common on the inner surface of the lip in the secondary stage of syphilis; deep in the fornix, where subject to little irritation, they are somewhat of the character of the patches under the tongue, but not so elevated. At the corners of the mouth, where they are very common, they are apt to ulcerate. At the edge of the lip a mucous patch may sometimes be seen to be continuous with a cutaneous papule. It is always to be remembered that the moist lesions of the first and second stage of syphilis are fruitful sources of contagion.

A diffuse infiltration of the borders of the lips may occur in syphilitic infants, which is marked by stiffness, a red-brownish color and a peculiar glossiness, and the development of radial fissures.

Gumma may develop in the lip and cause great destruction. (See Syphilis of the Mouth and Syphilis of the Tongue.)

## CYSTS

Cysts of the muciparous glands of the lip are not uncommon. Usually there are one or several isolated cysts projecting on the mucous surface, but there may be so many as to cause an eversion of the lip. They are small, round bodies, usually freely movable, and may appear bluish.

Single cysts are to be grasped, with their mucous covering, with fine-toothed forceps, and the projecting portion cut away with scissors, the remaining portion being grasped and shelled out. For a general cystic condition of these glands, a mucous flap is to be turned down, and the mass dissected out; after which the remnant of mucous membrane is to be sutured back into place. If the mucous covering is too thin or ragged to give promise of living, flaps can be turned from the lining of both cheeks and sutured in place.

## HEMANGIOMA

Angioma of the lip is not uncommon. In its early state, it usually shows a small purple spot, perhaps slightly elevated, which is compressible, but which returns to its original size when the pressure is released. From this it may extend until most of one or both lips and a large part of the face are converted into a purplish tumorous mass. When seen, they are unmistakable. There is a form of superficial angioma known as "wine spots," which may appear on any part of the body. They form a sharply limited reddish-purple stain. In infants an angioma may be pedunculated.

As soon as an angioma shows a disposition to spread, it should be destroyed; in this way the patient may be saved from one of the more extensive type. For the extensive angiomata, Wyeth's method of obliteration with boiling water is often the best treatment. In some part of the tumor 20 cubic centimeters or less of boiling water is injected with a hypodermic syringe. The injection of one part is to cease as soon as the skin turns white, but sloughing does not seem to follow. Some weeks later another part is injected, and so on until the tumor is obliterated. The surgeon wears heavy rubber gloves to protect his hands, and the syringe should rest in a basin of boiling water until immediately before it is to be used. The water in the syringe should be of boiling temperature. For injections of any extent a general anesthetic is needed, but as the injection takes but a few minutes, gas with oxygen is appropriate. The electric needle

and also the Paquelin cautery, thrust deep into the tumor, are used for destroying cavernous angiomata, but whenever possible, it is better to dissect out the mass with a sharp knife. For destroying large "wine spots," the repeated action of radium is most effective.

## ENDOTHELIOMA

We have seen two cases of diffuse endothelioma of the face, which caused considerable deformity, and several smaller ones (Fig. 300). None of these presented any of the characteristics of mixed salivary gland tumors. The tumor was soft, feeling almost like an angioma. The overlying skin was coarse and deeply pitted at the pores. A

Fig. 300.

Fig. 301.

Fig. 300.—Lymphangioma of the face in a young girl.

Fig. 301.—Case shown in preceding figure, after operation. A part of the face tissue was removed up as far as the orbit, including a section from the ala.

microscopical section showed masses of endothelial cells and fibrous tissue which had replaced most of the normal tissue.

The treatment of the larger tumors was not very satisfactory, but by turning back as thin a skin flap as seemed compatible with nutrition and then dissecting out masses of the tumor, considerable improvement was obtained (Fig. 301). There was always profuse hemorrhage, and in more severe cases, we had to do several operations before the best result was obtained, because of the fear that sloughing of the skin might follow a too radical operation. The coarseness of the skin persisted, and it was not possible to perfectly restore the contour of the lip and the ala of the nose. Injections of boiling water proved ineffectual in the one case in which they were tried.

## WARTS AND PAPILLOMATA

On the lips these are not uncommon. In two specimens in the Hunterian Museum, in London, papillomata of the lip had developed true horn. Papillomata should be removed, both because they are unslightly, and because they may be an early stage of cancer. The same is true of a chronic scurfy patch, which may appear at the border of the lip in persons who have reached the cancer age. These may persist for years, and yet a microscopical examination may show them to be squamous cell cancer or rodent ulcer. In some instances they gave a history of apparently disappearing at times and returning, so this should not mislead one into considering them simple. They may be destroyed with lunar caustic or chromic acid, but a safer plan is to make a fairly wide V-shaped excision of the full thickness of the lip. One can afford to take no chances when dealing with carcinoma, as these indolent patches and warts often take on rapid growth after being irritated by a partial excision or cauterization.

## CANCER OF THE LIP

Cancer is more common on the lower than the upper lip, and much less common in women than in men. According to Heimann, out of 509 cases of carcinoma of the lower lip, 473 cases were in males and 36 in females. Smoking has been advanced as a cause of carcinoma. It often occurs at the site at which a pipe is habitually held, but may arise at another site and in persons who do not smoke. It is more common among the inhabitants of the country, which may be due to the greater exposure and consequent changes in the skin. Any chronic change of the skin may be the starting point of carcinoma, as may any chronic irritation. Leucoplakia (see Chap. XXVI) may appear in one or several patches on the lip, and these may be followed by carcinoma. It is more frequent as age advances, but when it does occur in younger adults, is very malignant.

Carcinoma of the upper lip is usually of the type known as rodent ulcer, a carcinoma of the sebaceous glands, which is not very malignant either locally or in affecting the lymph nodes. Carcinoma of the lower lip is usually of the squamous type and occurs clinically in two forms: (1) The flat ulcer, which appears at the mucocutaneous border, advances slowly, remains shallow, is surrounded by little induration, and in the past has not been supposed to commonly invade the lymphatics early. This form of carcinoma may persist for years and

may even scar over only to reappear. (2) The other variety shows more elevation of the borders, much more induration, and deeper ulceration. It has a distinct tendency to run along the mucous surface into the cheek or gum. It early invades the lymph nodes and is very malignant.

**Diagnosis.**—The diagnosis of a well-developed carcinoma of the lip is usually simple and rests upon the ulceration, or scaly patch, surrounded by induration, and its chronicity—it having as a rule persisted for several months or years. Later in the disease there is salivation, cachexia, fetor, and enlargement or ulceration of the lymph nodes of the neck. The patient eventually dies of exhaustion or pneumonia, but very rarely from general metastasis. It is difficult to differentiate between a simple papilloma and a carcinoma, but a papilloma of the mucous border should be regarded as a carcinoma until proved otherwise by a very competent microscopist.

Occasionally chancre has been mistaken for carcinoma. The history of the case, the length of time that the sore has persisted, and the early involvement of the lymph nodes should give a hint that would at least call for a microscopical examination. A Wassermann test does not exclude carcinoma. Before carcinomatous glands become palpable, carcinoma of the lip usually presents an unmistakable picture. It is stated that the glands are not involved in 75 per cent of cases, which is probably a great exaggeration. It is often very difficult to feel small lymph nodes even in thin persons. So often have we found enlarged nodes at operation, when none could be felt previously, that we place no value on a negative result from such an examination. The rather general belief in the profession that the flat ulcers invade the lymph nodes late, or not at all, is now hardly acceptable. While there is apparently clinical evidence to support this view, still more recent careful observations tend to refute it. The length of time the carcinoma can lie dormant in the cervical lymphatics probably has much to do with it. We recently saw a case of rapidly growing squamous carcinoma of the submaxillary nodes in a man who had a healed scar on the lip, where a flat ulcer which existed two years had been destroyed with caustic eight years previously. Examples of lymphatic infection appearing two or three years after the destruction of the lip ulcer are not at all uncommon. On the other hand, nodes may be enlarged from absorption of septic material from the ulcer or from accidental causes.

While it is important to make a diagnosis in advanced cases, it is even more important to make a diagnosis of the incipient ones. Every

chronic papule, wart, tumor, or abrasion of the lips in persons who have reached the cancer age should be excised and subjected to a microscopical examination. If there is any doubt in younger persons, they should be given the benefit of the same procedure; for, though less frequently, cancer does occur under thirty years, and it is then always very malignant.

**Treatment.**—As already stated, incipient and early carcinoma of the lip can be destroyed with caustics, x-ray, or radium. But to be safe, the destruction must be deep, and when caustic is used, the resulting defect requires more time to heal and leaves more scar than does a clean excision. In certain instances the prejudice of the patient against "the knife" might force one to adopt such measures. It is probable that both radium and the x-ray are more efficient than caustics. Although they will, when properly applied, destroy the local growth, they can have little or no effect on infected lymph nodes. Although it may be possible that slow-growing carcinomata of the lip infect the lymphatics less early than at most other sites, still it is a safe rule to regard them as infected in every case of carcinomatous ulceration or induration, and to remove them accordingly. *We have no right to assume that because the lymph nodes are not palpable they are not infected; and the only safe plan is to remove them in every instance where there is a definite carcinomatous ulceration and induration, no matter how small.* The nodes first infected are the submaxillary and the submental, and later the deep cervical. The extent to which the lymphatics are to be removed is to be determined by the clinical character of the growth and the special indications as found at operation. If no, or only slight, enlargement of the submental or submaxillary lymph nodes is found after turning down the skin flap, then one may content himself with removal of the tissue that carries these, and the superior deep and the superficial cervical nodes *en masse.* If, however, the superior cervical are palpably enlarged, then all the cervical nodes should be included on one or both sides. This is a more conservative course than is advocated in print by some surgeons, but it is our present rule. While it is not proper to neglect the lymphatics because, possibly, the majority of these tumors infect them only late in the disease; on the other hand, patients should not be subjected to needless surgery. There is some presumption in the attitude that the only risk the patient runs is in not making the operation sufficiently extensive. There is the possibility that there will be some infection of the wound, and a prolonged operation complicated by an infected deep dissection of the neck, especially in old persons,

may be a serious matter. This is not our attitude toward the lmph nodes in the presence of a cancer of the tongue. Then an attempt is made in every instance to remove all of the lymph nodes on at least one side of the neck, but there is abundant clinical evidence to show that in most instances lip carcinomata are much less virulent. Possibly an exception should be made of cases of indurating carcinomata of the lip in young people, persons under forty or forty-five years; here the lymphatic excision should be as radical as for carcinoma of the tongue.

Fig. 302.—Showing a patient in whom one half of the lower jaw and cheek was removed to get rid of an inoperable carcinoma of the mouth, resulting from a carcinoma of the lip. Several unsuccessful operations had been done on the lip and mouth. The patient was made much more comfortable by the removal shown, and the growth did not recur in the mouth.

In carcinoma of the face and mouth it is usually not practical to remove all of the lymphatic ducts between the growth and the first groups or nodes, but fortunately, secondary infection rarely occurs in these ducts. In the neck the ducts, as well as the glands, should be removed, if for no other reason than that by so doing all glands will be excised.

In the excision of the primary focus, conservatism should have little place. When one is tempted to spare tissue, he has but to think of a few cases he has seen in the end stages of mouth carcinoma to steel him to the safer course (Fig. 302). In dealing with a carcinoma of

the lip, the surgeon had best forget he is dealing with a lip and think only of the growth. In the slow-growing flat ulcers of older persons, he may content himself with an excision that runs 8 or 10 millimeters to each side of the evident disease, prolonging the excision for 3 or more centimeters in the direction of the lymph streams. In the more rapidly growing, indurating variety, the incision had best be made at least 2 centimeters from its borders. If the growth has run on the cheek or upper lip, it should be treated in the same way. If it has encroached upon the gum, apparently involving only the superficial tissues, these are to be removed, and the bone sawed or bitten away down to below the bottom of the tooth sockets. If the induration is deep or if the teeth are loose, showing the tooth sockets to be frankly involved, then a section of the whole thickness of the jaw-bone should be removed as part of a block incision. If the involvement is of the upper jaw, then, with a sharp chisel, a part of the maxilla is to be removed. *In every instance the whole mass is to be removed in one block. The incisions should be all outlined before the cutting is begun in any part.*

**Excision of Growth and Ulcers of Doubtful Character.**—Warts, persistent papules, or exfoliating patches should be removed by a V-shaped incision, through the thickness of the lip, that extends at least ½ centimeter to each side of their base. The incision is first outlined, and the sides of the V should be bowed somewhat outward. as this will lessen the subsequent defect, due to scar contraction (Figs. 228 and 229). The lip is then injected with a 1 per cent novocain, with adrenalin, solution, and grasped on the outer side of each mark with artery clamps held by an assistant, but not locked. The forceps will control the bleeding and steady the lip. The center of the base of the wedge to be excised is grasped with a vulsellum forceps in the hand of the surgeon; the excision is then made with a sharp knife or with sharp scissors. Hemorrhage is controlled by the sutures, but they are not to be drawn tight. If, after suturing, there is still oozing, an extra through-and-through suture may be drawn tight, the latter to be removed in six or twelve hours. The specimen should be examined microscopically.

**Excision of Indolent Carcinomatous Ulcers.**—This may be done by a V-shaped incision made 1 centimeter on each side of the base of the ulcer.

**Excision of Indurating Carcinoma of the Lip.**—Unless of exceedingly slow growth, the greater part of the lower lip with the soft tissues covering the chin should be removed.

The operation on the primary growth may be done at the same time as the excision of the lymph nodes, or the latter may be done at a subsequent sitting.

*An important point to bear in mind in these and in all cancer operations is: That a man who undertakes a primary operation on a case fitted for radical treatment assumes a great responsibility; and unless he does his work correctly and thoroughly, he does his patient harm.* In most cases the primary growth and the submental, submaxillary, and superficial cervical lymph nodes can all be removed at one or several properly planned primary operations; but to work in the dense scar that remains after the first operation is extremely tedious and difficult, and it is at best guesswork. If the neck has been invaded and the operation for the primary growth is not a success, the condition is still more hopeless; for the lymph, seeking new channels, is very apt to cause infection of nodes which are much less accessible to surgical interference.

Operations for secondary infections in regions which have not been disturbed—for instance, the removal of the deep cervical nodes after there has been a proper cleaning out of the submaxillary and submental regions—may be undertaken with a reasonable amount of confidence, but operations in a region that has been unsuccessfully invaded are most likely to prove unsuccessful.

Before closing this chapter, it is well to say a word in regard to unilateral versus bilateral removal of the lymph nodes in lip carcinoma. In very early cases situated well toward one corner of the mouth, it may be proper to do a unilateral neck operation, but clinical illustrations of early bilateral infection of the lymph nodes from a unilateral focus are so common, that the safer plan is to make a bilateral excision of at least the submaxillary and submental nodes in all cases.

**Prognosis.**—Carcinoma of the lip gives the best operative result of any form of carcinoma, and it is probably perfectly fair to state that the cures should be above 75 per cent.

## CHAPTER XXVIII

## AFFECTIONS OF THE NERVES OF THE FACE

### MOTOR DERANGEMENT

Motor abnormalities are of two general kinds: paralytic, and spasmodic.

### PARALYTIC AFFECTIONS

If the cortical cells in the motor area of the brain, or any of the conducting paths between these cells and the muscle they innervate, are interfered with, there will be a partial or complete paralysis of that muscle. This may be due to a destruction of or pressure upon the motor cells. It may be due to destruction of or pressure upon the conducting paths within the brain; or it may be due to section of or pressure upon a peripheral nerve. In any case the result will be the same. Motor impulses can no longer reach the muscle; therefore voluntary contractions are no longer possible. At first such a muscle can be made to contract by some local stimulus. Later, however, if the lesion is situated below the motor nerve nucleus, the muscle will degenerate. After complete division or blocking of a motor nerve, atrophy of the muscles follows quickly, and deformities are not uncommon. The latter may be due either to the unopposed action of other muscles, or to shortening of the paralyzed muscle during atrophy. The condition of the motor nerve of a muscle is best determined by electrical tests.

**Treatment.**—If possible, the cause of pressure or of damage to the nerve should be remedied. If it is found that the normal conducting path will not be reëstablished spontaneously, or by such perineurial operations as may be indicated, then, in the case of certain important nerves, resort to direct nerve suture, or nerve transplantation, is indicated. In complete section of a nerve, direct nerve suture, grafting, or transplantation should be done as soon as possible. It is only when the nature and extent of the lesion is in doubt that the operation is postponed until time has demonstrated that the lesion will not be remedied spontaneously. When a peripheral motor nerve is cut some place below its motor nucleus, the fibers distal to the lesion degenerate. When connection is established between the distal part

of the motor nerve and its own, or some other, motor nucleus, the nerve fibers grow downward into the distal part of the nerve, and function is reëstablished.

**Trifacial Nerve.**—Besides carrying sensations to one-half of the face, each fifth cranial nerve carries motor fibers to the muscles of mastication. These will be paralyzed after section of the posterior root of the Gasserian ganglion, and after removal of the ganglion, if the motor root is included. There is usually a transient paralysis, more or less complete, after injection of the third division of the fifth nerve with alcohol.

Paralysis of the muscles of mastication of one side causes little inconvenience and is not very noticeable. On palpation it will be found that the masseter or the temporal muscles either do not contract or contract less vigorously than those of the uninjured side. In unilateral paralysis the chin deviates toward the paralyzed side when the mouth is widely open, owing to the unopposed action of one external pterygoid muscle. If there were a complete bilateral paralysis, the lower jaw would hang down.

**Facial Nerve.**—The facial, or seventh cranial, nerve transmits motor impulse to one-half the face and scalp, exclusive of the muscle that elevates the eyelid, the ocular muscles, the muscles of the tongue, and the muscles of mastication. It also supplies impulse to one of the muscles of the middle ear, to the stylohyoid, and to the posterior belly of the digastric muscle. The chorda tympani, which carries the sensation of taste, is, for a part of its course, incorporated in the seventh nerve. The facial nerve runs along a tortuous course through the temporal bone, and is not infrequently injured in fractures of the skull.

Paralysis of the face may also be caused by accidental injuries to the nerve, or infections or growths along its course. It may result from an intracranial lesion, either in the cortical motor area, in the nucleus of the seventh nerve, or along one of the conducting paths to or from the nucleus.

Bell's palsy is a facial paralysis due to injury or disease of the facial nerve. It may be due to traumatism or tumor, but most cases develop suddenly without injury, as a result of exposure to cold, or to some infection. Rheumatism and gout are supposed to be etiological factors. In a few cases in which the nerve has been examined shortly after paralysis of the latter kind, a degenerative neuritis has been found. This comes on quickly and may be fully developed in a few

hours or days. Paralysis, due to tumors or middle ear disease, comes on more slowly and is usually not so well defined.

**Symptoms.**—The symptoms will vary with the location and extent of the lesion. A lesion situated in the face area of the cortex, the nucleus of the facial nerve, or the conducting path between them will cause a paralysis of the opposite side of the face. Shortly after the nerve leaves its nucleus in the midbrain, the fibers cross the median plane to be distributed to the face on the opposite side. Lesions below the point where the nerve tracts cross will cause paralysis of the face on the same side. If a gross lesion is situated along the path in which the facial and auditory nerves lie in close contact, it is likely that both nerves will be affected. If the lesion is situated between the junction of the pars intermedia and the giving off of the chorda tympani, it is probable there will be loss of taste on one-half of the body of the tongue. The face shows characteristic changes, varying with the extent of the paralysis. In a complete one-sided paralysis there will be a smoothing out of the natural creases of the forehead, with an inability to raise or wrinkle the brow, and there will also be a slight drop of the eyebrow of that side, and an inability to close the eye. When an attempt is made to close the eye, the globe turns upward, and there is a slight movement of the lower lid. This latter movement is probably due to certain muscle fibers innervated through the sympathetic. In a paralysis of long standing, there may be considerable irritation of the eye, due to the inability to close it. The buccinator muscle will remain flaccid, and food will collect in the buccal pouch on that side. The mouth will be drawn to the opposite side by the unopposed action of the opposite buccinator. It will be impossible to pucker up the mouth. There are other evidences of the paralysis present, but these are the most noticeable. (Fig. 303.)

Complete double facial paralysis is, at first sight, not so noticeable as is paralysis of one side, owing to the fact that the mouth is not distorted. However, there is a peculiar mask-like appearance of the face, which is due to the immobility of the muscles of expression. We have seen one such case, in the service of Dr. Schwab, at the City Hospital, which was part of the symptom complex of a general paralysis.

**Prognosis.**—The prognosis of the non-traumatic form, not due to a growth, is good, but recovery is not always complete. Mild cases may recover in a month, and the usual duration is three to five months. In the traumatic form the prognosis will depend upon the extent and character of the injury. A partial section of the trunk of the nerve

usually recovers spontaneously, because the ends of the divided fibers are still held in close proximity. Complete recovery is still more apt to occur after contusions. If, immediately after an injury of the nerve or one of its branches, the paralysis is not complete in the part supplied by the injured branch, then there is good reason to believe that there will be considerable spontaneous recovery.

The prognosis of a paralysis due to perineurial tumors, or inflammatory growths, will depend upon their nature and accessibility. The prognosis of a paralysis due to a malignant growth is necessarily bad. Where the paralysis is due to simple pressure, recovery will usually take place on removal of the pressure.

Fig. 303.—Facial paralysis.

**Treatment.**—When there is a complete transverse destruction of the nerve sheath, surgical repair may be undertaken immediately, but even the history of an injury does not always preclude spontaneous recovery. In non-traumatic Bell's paralysis, as long as the electric excitability remains unchanged, no local treatment is necessary, but it is safer to use massage or electricity to prevent atrophy or degeneration of the muscles. When the paralysis remains unchanged, the question of nerve repair or of an anastomosis of the facial to some other motor nerve arises; but the latter should not be considered until after six months, and it is better to wait a year. Hackenbruch reports a favorable result by operation after seven and three-fourths

years, Taylor after twelve years, Elsberg after twenty-nine and one-half years.

Ballance, of London, first did facial-accessory anastomosis on the human in 1895. When a nerve is cut in two, or is subjected to considerable pressure in any part of its course, the axis cylinders degenerate in the distal part of the nerve. If the open end of the distal part of the nerve sheath is properly united directly, or even closely, to an opened sheath of a motor nerve that still retains its physiological and anatomical central connections, then the axis cylinders will grow downward into the distal previously functionless part of the sheath. This reëstablishes physiological connection between the end organs and the central nervous system. The object of anastomosing the distal part of a paralyzed facial nerve with the trunk of a neighboring functional motor nerve is that the intact nerve can be made to take over the function of the facial, and that a more or less satisfactory innervation of facial muscles will result. The spinal accessory or the hypoglossal is the nerve chosen. Even when the technic and healing are satisfactory, the results of the operation cannot be ideal. It is necessary to educate the cortical centers to take on a new function for which they were not intended. After a successful operation of this kind the tone and grosser movements of the facial muscles will be restored, but not the finer movements of expression. Further, after uniting the facial to either the accessory or hypoglossal nerves, there are usually persistent, objectionable, associated movements—such as grimaces of the face when the patient shrugs his shoulders or moves his tongue. The younger the patient, the better chance he has of overcoming or lessening these association movements. Almost perfect results are to be hoped for after uniting the cut ends of the trunk of the facial nerve, but unfortunately the lesion is often situated in an inaccessible part of the nerve. On the whole, the results of a satisfactory anastomosis are so much better than the facial paralysis that this operation is well worth doing.

Faulty technic, or sepsis in the wounds, greatly lessens the chances of good result. In about two-thirds of the collected cases results have been rather satisfactory.

The choice of the nerve to be used, the hypoglossal or the accessory, requires some consideration. The centers which send impulses through the hypoglossal nerve, normally, give rise to finer movements than those supplying the accessory. It might, therefore, be surmised that the hypoglossal is better adapted for taking over the functions of the facial. On the other hand, the loss of one hypoglossal is a much more serious matter than the loss of the accessory. If the functional

result of the operation proved a failure, after using the hypoglossal, the patient would be much worse off than before the operation.

**Hypoglossal Nerve.**—If motor impulses are shut off from one half of the tongue, it will deviate to the paralyzed side when protruded. If the paralysis persists, that side of the tongue will later shrink. The motor supply of the tongue is through the hypoglossal nerve, which comes from the hypoglossal nucleus in the floor of the fourth ventricle. A section of the nerve is not infrequently removed in excising an infiltrating growth in the submaxillary region. It might also be cut accidentally in operations about the upper part of the carotid sheath. Paralysis of half of the tongue has resulted from pressure upon the nerve in the anterior foramen, due to caries of the occipital bone. The nucleus of the hypoglossal nerve may be involved with others in a lesion of the bulb. Functional motor disturbances of the tongue are not infrequent.

## SPASMODIC AFFECTIONS

These may, in a general way, be divided into two kinds: (1) those that are directly dependent upon some physical irritation; and (2) those that are more or less under the control of the volition. An example of the former is tetanic closure of the jaws, due to some lesion along the distribution of the fifth nerve (page 113). A common example of the latter is facial tic, but this may start with, or even be dependent on, some definite pathological or other irritation.

**Facial Tic.**—This is a motor disturbance affecting, chiefly, muscles supplied by the seventh nerve, and characterized by a set of spasmodic contractions of certain muscles, recurring at more or less regular intervals. There are one or more sharp contractions of the affected muscle, followed by a period of relaxation. When the spasm involves a number of groups of muscles, the spasm may start in one set and travel in a more or less regular sequence through the various groups involved. The interval between spasms varies in different patients, and at different times in the same patient. This interval is somewhat under the control of the patient, but after holding it in abeyance for some time, the spasms recur in quick succession.

It most commonly appears in the zygomatic and orbicularis palpebrarum muscles of one side, but may spread to other groups; and the tongue, neck, shoulder, and arm muscles may all become involved. Occasionally the spasms are painful, but this is rarely the case.

Facial tic seems frequently to have its origin in some local irrita-

tion, either pathological, or external—such as an uncomfortable collar—but it is looked upon as essentially a habit spasm. According to Head, it develops only in persons of a certain neurotic taint of mental habit—such as persons who make it a practice of touching every other post that they pass, etc. In a few cases it is evident that it is mainly a subconscious voluntary action. As a rule, the mental element is exhibited by the power to hold the spasms in abeyance for a certain time. Regardless of the nature of the original irritant, after the spasms have persisted for a length of time, the psychic element is the all-important factor.

**Prognosis.**—In the earlier cases great good, even cure, may result from proper treatment. The old long-established cases are liable to persist.

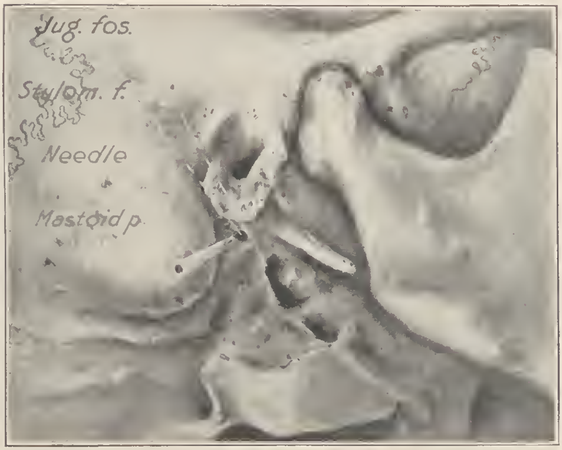



Fig. 304.—Showing stylomastoid foramen from which the facial nerve emerges. Also represents a needle penetrating to the foramen. The needle enters in front of the middle of the mastoid process. The internal jugular vein in the jugular fossa is to be avoided.

**Treatment.**—A physical cause should be sought and, if possible, removed, but the treatment is a problem for a neurologist, rather than for a surgeon. In some cases good has resulted from temporarily blocking the facial nerve, in the hope that a few months respite will break the habit, but after such an operation, the surgeon must not be surprised if the tic recurs, or appears in some other set of muscles.

There are several ways of blocking the nerve. One is to cut downward and stretch it. Another is to inject a weak alcohol solution, 40 or 50 per cent, around the trunk with a hypodermic needle (Fig. 304). After these operations, the nerve is more or less paralyzed, but

will recover in nine months, or even less time. Before doing such an operation, the patient and friends should be given to understand the results in an indisputable manner. Lawsuits have arisen for lack of a clear understanding on this point.

## TIC DOULOUREUX AND SPHENOPALATINE NEURALGIA

The term neuralgia is one that is somewhat loosely applied. It is generally used to designate a ~~recurrent~~ localized pain, that cannot be accounted for by any recognizable lesion. According to our limited knowledge of the subject, neuralgia seems to be due to pressure, toxemia, or malnutrition, the last including the lack of an accustomed stimulation.

As the fifth cranial nerve carries all common sensations from the mouth, teeth, and face, neuralgias of the head and face are very common, and clinically present several varieties. The pain may radiate over the distribution of several nerves—as one that involves the fifth cranial and several cervical nerves—or it may be confined to one nerve.

## FIFTH CRANIAL NERVE

This nerve carries both motor and sensory fibers. It supplies motor impulses to muscles of mastication, the mylohyoid muscle, the anterior belly of the digastric muscle, and the tensor palati and tensor tympani muscles. It carries sensory impulses from the whole face and its contained cavities, the mouth, nose, and orbits.

The sensory part of the nerve has on its root, situated on the inner end of the petrous bone within the skull, the Gasserian ganglion, which is analogous to a posterior root ganglion of a spinal nerve. The motor part has no connection with the ganglion, but joins with the sensory fibers of the third or mandibular division.

The sensory fibers are arranged in three groups. The first or ophthalmic division arises from the innermost part of the ganglion, emerges from the skull through the sphenoidal fissure, and traverses the roof of the orbit. The second or maxillary division arises from the midpart of the ganglion, emerges through the foramen rotundum, crosses the sphenomaxillary fossa, and traverses the floor of the orbit. The third or mandibular division arises from the outermost part of the ganglion, and leaves the skull through the foramen ovale. Before any of these divisions leave the skull, they send off dural branches. (Fig. 325.)

There are many conditions occurring in the mouth, and especially in connection with the teeth, that demand surgical or dental treatment on account of the pain accompanying them; and in these the pain is often of a referred neuralgic character. Many attacks of neuralgia will yield to medical treatment.

## TIC DOULOUREUX: MAJOR NEURALGIA OF THE FIFTH CRANIAL NERVE

A convulsive chronic neuralgia limited to the fifth nerve is designated as a major tic, or tic douloureux, and this can only be relieved by some surgical procedure that blocks the conducting power of the affected nerves. Possibly a practical way of putting it would be to say that every persistent incurable neuralgia of the fifth nerve is clinically a major tic and should be so treated. While no patient should be allowed to suffer unnecessarily, because his ailment does not fall in with our preconceived ideas of what constitutes a major tic, nevertheless it is important that the surgeon, the consultant, and the dentist be able to recognize the disease when present and to differentiate it from other neuralgias and extraneural conditions that simulate it. Otherwise the patient may be subjected to an unnecessary operation, or the surgeon may find himself embarrassed by a faulty prognosis. If the nerve-blocking operation is successfully done to relieve the referred pain of an unrecognized malignant growth, valuable time may be lost before some gross symptom calls attention to the tumor. When the dentist fails to recognize a true major tic, he is likely to persist in useless operations and extractions, which give his patient no relief and which may cause his skill to be questioned.

A very slight acquaintance with the symptoms of the disease will exclude the possibility of not recognizing it when present. The recognition of its counterfeits is, in most cases, quite as simple, but may be so difficult as to baffle the most skillful and most painstaking neurologist.

**Symptoms.**—In a carefully observed series of cases of true major tic, there were some features common to all. Within certain limits, the clinical picture in the individual cases varied considerably, but by excluding from operation cases that varied beyond these limits, we have done very few inappropriate operations. The clinical features that were common to all of the true cases that we have observed are:

1. The neuralgia is confined to the distribution of one or more branches of the fifth nerve on the affected side. There are cases which appear to be exceptions to this rule, but from the anesthesia resulting

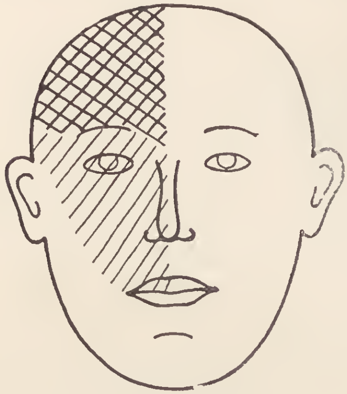


Fig. 305.

Fig. 306.

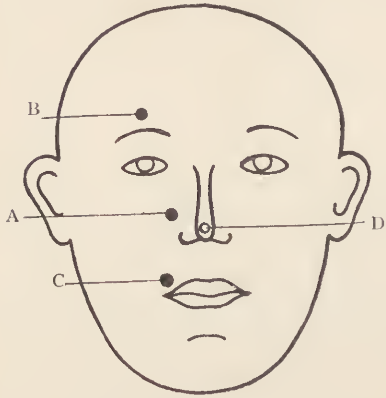



Fig. 307.

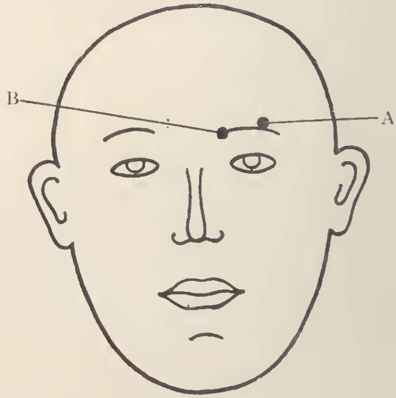



Fig. 308.

Figs. 305 and 306 show the anesthesia resulting from a deep injection into the first and second division of the fifth nerve. From the anesthesia it will be seen that the area behind the ear is supplied, in this case, by the first division of the fifth nerve, which accounts for the fact that the pain radiated behind the ear. This is not the average distribution.

Fig. 307.—Case of woman 65 years of age. (A) pain came on at this point in 1905; (B) pain came on at this point in March, 1908; (C) pain came on in 1905 sometime after the appearance at (A); (D) touching the spot (D) would start pain in (A and B).

Fig. 308.—Man 53 years of age. (A) pain came on in this spot in 1884, and was somewhat relieved by cutting the supraorbital nerve in May, 1908; (B) pain came on in this spot after cutting supraorbital nerve.

from injections, it was learned that the distribution of this nerve varies considerably, the most striking departure from the average being that the first division, through the supraorbital, may supply

the area behind the ear. This purely local distribution of the pain is in striking contrast to the pain, which Sluder has described as neuralgia due to an irritation of the sphenopalatine, Meckel's, ganglion. In this the pain radiates over the distribution of the first and second divisions of the fifth nerve, over the occiput, side of the neck, and down the arm, forearm, and hand (Figs. 305 and 306). We have occasionally seen a true tic douloureux associated with pain of some other part. In one case there was a pain in the back of the thigh that came on and passed off with the facial pain.

2. The pain in every case came on in a rather definite spot, from which it might radiate in various directions over areas belonging to the fifth nerve of the same side (Figs. 307 and 308).

3. Whether the first intimation was a severe pain or a paresthesia so slight as to be compared with the touch of a feather, and whether in the later stages the patient had but occasional twinges or the pains followed each other so closely as to destroy all rest and drive the sufferer almost to desperation, the pain was always, in all stages of the disease, paroxysmal.

If the first pain was severe, the patient might have thought that he had been struck or stung; but severe, or almost imperceptible, the first pain, with but very few exceptions, lasted but a second or a few minutes. Later the pain returned—that day or the next, or in a week, month, or year, but it returned. And the subsequent history is that the intervals between the pains shortened, and that the length and intensity of the individual twinges increased as time went on. In one of the exceptional cases referred to, the first paroxysm lasted four hours.

To the paroxysmal character is later added an irregular periodicity, which may be evidenced by the pain being present on alternate days —more frequent or more intense on alternate days—or present for indefinite stretches of time that last for weeks or months, alternating with periods of comparative or complete freedom. A very marked, regular periodicity, especially in a recent case, is strong evidence against but does not absolutely exclude the possibility of its being a true major tic. Such neuralgias are usually of the variety known as sun pains, which seem to be due to some malarial or climatic influence or sinus infection. In a very few cases there has been a continuous dull ache over some part of the nerve, with recurring paroxysms of a sharper character.

4. When the pain returns, it is in the same spot in which it first appeared, and although it may radiate, the pain is always sharpest

in one certain place that can often be covered by the end of a lead pencil. Later other such pain areas may develop, but they are in turn equally definite (Figs. 307 to 309). After some months or years the primary pain area may be less severe. The pain may come in several of these spots at once, in one or the other by turns, or play from one to the other. The pain may remain confined to the distribution of the branch over which it first appeared, or it may involve other branches or divisions of the nerve successively. The second and third divisions are the ones supposed to be most commonly affected, and some observers maintain that involvement of the first alone is never a true major tic.

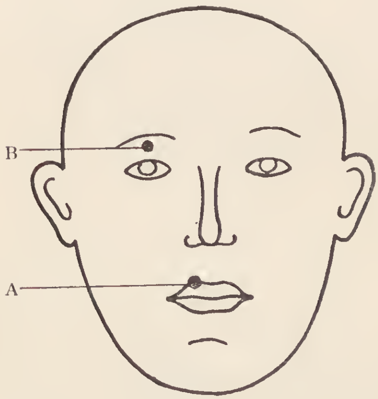



Fig. 309.

Fig. 310.

Fig. 309.—Man 68 years of age. (A) pain came on in this spot December, 1906; (B) from May, 1909, touching this spot caused exquisite pain.

Fig. 310 is intended to show the direction and distance that the pain radiated from the pain spots. The fact that the pain radiated behind the ear tended to cast some doubt upon the diagnosis before the injection was made. Result of two injections is shown in Figs. 421 and 422.

5. The neuralgia is usually confined to one side, but involvement of both sides is not uncommon.

6. The trunks and branches of the affected nerve may or may not be tender, but in almost all cases there are spots over the distribution of the nerve, stimulation of which causes a twinge in the pain area. The touch of a finger, a breath of cold air, in some cases heat, in others the taking of food or liquids in the mouth or the act of swallowing, or a sudden movement or jarring—any or all of these may bring the pain. One old lady could not let a bright light fall on the eye on the affected side without a sharp pain in a spot to the outer side of the ala of the nose (Fig. 307). A number could not take

sweet or sour things, and one suffered a supraorbital pain whenever food touched the velum. It is pitiful to observe the extremes to which sufferers will resort to avoid the stimuli that they know will produce pain. Some of them will talk from, or will take food or drink into, only one side of the mouth. One patient would go for days without swallowing even water, and others will not enter a room until they are sure all windows are closed. Some, for months at a time, will not wash one side of the face or brush the teeth.

8. In the older cases, though there is evidence of extreme pain during the attack, the patient seems to have become accustomed to it and seldom makes an outcry or demonstrative complaint.

9. Contrary to the repeated statement that it is essentially a disease of middle or later life, it appears in all decades from the second on. The earliest case of ours was nineteen years, but in most instances it first appeared between forty-five and sixty years.

10. This form of neuralgia is extremely stubborn to treatment. For a time most of them were influenced by medicinal treatment, but, sooner or later, this seems to lose its effect. In most cases of long standing, one or a number of teeth had been extracted, usually with little or no benefit. Removal of pulp stones, abnormal roots, misformed teeth, impacted or unerupted teeth, or necrosed bone had in many cases given temporary relief, possibly for months; but in all cases the pain returned. Excision of the accessible parts of the affected nerve trunks had given temporary relief, as had injections into the peripheral portions of the nerves. But even where the relief obtained lasted some years, the pain eventually returned. It is not impossible, however, that cases, giving typical symptoms of major neuralgia, have been cured by some other than surgical means. Naturally, such cases are not likely to come under our direct observation.

The time the neuralgia had persisted before coming under observation varied from two months to thirty years, so that in these cases there had been ample opportunity for trying various measures.

The duration of the disease is one of the strongest points in the diagnosis; it is the recent cases that require most careful differentiation. Pains due to pulpitis, neuralgias due to malaria or pus infections, pain due to malignant growths, or any other acute cause, will, if observed long enough, show some change or characteristic that will differentiate it from a true tic, or the general health or condition of the patient will give some clew to the cause. Except indirectly, through loss of sleep or lack of food during an acute

exacerbation, this disease affects the general health to a remarkably small degree.

In very few cases have we observed trophic or functional changes, such as anesthesia, reddening of the skin, or lacrymation from the affected eye during the attack. In those cases where there was a motor convulsion of the face or neck muscles, we were inclined to believe that the twitching was voluntary though subconscious.

**Diagnosis.**—From these observations, it seems logical to conclude that a paroxysmal pain, coming on suddenly in one or several spots over the distribution of the fifth nerve, returning persistently at the same spot, whether or not other similar pain spots later appear, and not yielding to medicinal or surgical treatment or any associated lesions, is a true major tic. The conclusion that no neuralgia except that which exactly corresponds to all of these conditions can be a major tic is probably not warranted.

## SPHENOPALATINE NEURALGIA

Sluder has called attention to a pain syndrome, which seems to be due to an irritation of the sphenopalatine ganglion. This form of neuralgia is fairly common and should be differentiated from tic douloureux. His description of the syndrome is concise and clear, and we, therefore, quote him, as follows:

''When seen from the beginning, the pains of postethmoidal or sphenoidal diseases have usually preceded the development of the characteristic neuralgia picture. I have also remarked that after the neuralgic manifestations have continued for some time (approximately four weeks) they begin to run irregularly, assuming the form of migraine, which may persist even for years, after all local inflammatory conditions have disappeared.

''One of the most striking manifestations of disturbance in the sphenopalatine ganglion is the wide and characteristic distribution of pain along definite lines. These neuralgic manifestations can be evoked by mechanical irritation of the ganglion, by the faradic current, and by therapeutic injections of alcohol. The neuralgia is described as a pain at the root of the nose, sometimes also in and about the eye, taking in the upper jaw and teeth; sometimes also the lower jaw and teeth, and extending beneath the zygoma to the ear to take on the form of earache. It is emphasized at the mastoid, but is nearly always severest at a point about two inches posterior to the mastoid, thence reaching backward by way of the occiput and neck; and it may extend to the shoulder blade and shoulder, and in severe attacks to the axilla, arm, forearm, hand, and fingers. This is the most frequent picture, as I have observed it. Sometimes the patient complains also of a 'stiff' or 'aching' throat, without inflammation; of pain, or oftener of itching, in the roof of the mouth; or of pain inside the nose.

"Along with the pain there is, also, on the affected side, slight anesthesia of the soft palate, and of the pharynx as far down as the lower part of the tonsil, and also in the anterior lower part of the nose.

"In a large percentage of cases, the neuralgia is accompanied by motor disturbance, affecting the configuration of the soft palate. The palatine arch on the affected side is often higher than on the well side, and during movement, the median raphe is deflected from the affected side. Taste is usually less acute on the dorsum of the affected side."

**Pathology and Etiology.**—Little is known of the pathology of this disease. It has been supposed to be an ascending neuritis; but the symptoms do not correspond with those of an ordinary neuritis, and little has been observed by microscopical examination of sections.

The etiology is but little less obscure. The history of certain cases of tic douloureux suggests very strongly the origin in some tooth lesion, but a characteristic of both forms of neuralgia is that relieving the supposed exciting cause does not relieve the pain. It is not improbable that many may be the sequelae of sinus disease.

**Treatment.**—Once the diagnosis is established, resort should be had to some measure that will block the sensory conduction of the affected nerves. In tic douloureux, at first superficial injections may give relief for many months; but later these lose their effect, and some operation on the proximal portion of the nerve is usually indicated. This will consist either of cutting the nerve, and possibly removing a portion, or of injecting some fluid around the trunk that will influence its power of conducting these abnormal painful sensations.

We know little of the cause or of the pathology of this disease. But in spite of the fact that it is often called a central neuralgia, some part of the irritation must be peripheral; for if it were otherwise, no amount of blocking of the peripheral paths would influence the pain. Not knowing what the irritation is, or where it is operative, it is reasonable to conceive that the closer to the brain the block is made the more likely is it to be successful in curing. This is borne out by clinical observation. The peripheral operations are the simpler, safer, and least efficient. The deeper operations require more skill and give more lasting relief.

Injections, according to our observations, give relief for as long if not for a longer time than do peripheral nerve sections or avulsions. They cause less immediate disability and discomfort than cutting operations, and as a rule, are regarded more kindly by the patient. Therefore, no description will be given of the mode of making these nerve sections. Descriptions of these operations will

be found in any textbook of surgery, most concise in Kocher's Operative Surgery.

It is difficult to say just what is the rationale of the injection treatment, but clinically it is shown to be very successful. There are two distinct classes of fluids that are used today for injections into the branches of the fifth nerve. The most popular of these is alcohol in various strengths, with or without other substances in solution. The formula that we have generally used closely resembles that proposed by Patrick, and is as follows:

Novocain, 2%.
Chloroform, 5%.
Alcohol, 70%.
Water, 23%.

Deep injection of the ophthalmic division has been abandoned owing to the danger of injury to the optic nerve and other complications.

Before any injection is made, the skin should be cleansed. Before an irritating solution is injected, it is better to anesthetize at least the skin by the injection of a small quantity of $\frac{1}{4}$ to 1 per cent solution of novocain, the strength depending upon the quantity that is injected. Before making a deep nerve injection, we have made it a practice with ordinarily strong patients to inject $\frac{1}{150}$ grain of scopolamin and $\frac{1}{6}$ grain of morphin into the arm four hours before the operation, and repeating the dose a half hour before operation. This usually has the effect of very much reducing the pain of the injection. In very old persons one such dose has had the desired effect. Ordinarily this is a very painful operation.

The injection of the alcohol causes more pain than introduction of the needle. This may be lessened to a large extent by anesthetizing the patient lightly with nitrous oxide after the needle has reached the proper point for injection.

The needle used for anesthetizing the skin may be very fine, but that used for the nerve injection must be coarse and rather blunt, and strong in proportion to the depth at which the injections are made (Fig. 311). The blunt needle is less apt to open a vein and liberates the fluid close to the point. The injections may be made into the nerves, as they emerge from the superficial foramina of exit—which might be termed peripheral injections; or they may be made with the idea of attacking the nerve trunks, just as they emerge from the foramina that furnish their exit from the cranial cavity—

which might be termed deep injections. The former could be considered minor, and the latter major operations. There are certain nerves that may be attacked at intermediate points.

**Injection of the Peripheral Branches of the Fifth Nerve.**—For technic and topographical anatomy of peripheral injection of fifth nerve branches see chapter on local anesthesia. The needle is made to penetrate deeply into the tissues before the fluid is liberated. For these peripheral injections a small quantity ½ to 1 cubic centimeter of fluid is sufficient.

Besides the knowledge of the exact or relative position of the foramina of exit, two other things are helpful in locating the nerve trunks: (1) the nerve trunks are sometimes tender to touch; and (2) an exquisite pain, which radiates over the distribution of the nerve, tells when it is touched by the needle or irritating fluid. When the injection fluid is of an anesthetizing character, this severe pain lasts but a few minutes after the first few drops are liberated. During the progress of the injection, the skin, or mucous membrane

Fig. 311.—Needle used for deep nerve injections.

over the distribution of the nerve, should be repeatedly tested for anesthesia, which, when obtained, assures the anatomical success of the operation. The point of the needle is shifted in the tissues during the injection so as to distribute the fluid over a sufficient area to insure its coming in contact with the nerve and to avoid the risk of placing the whole injection in a vein.

The effect of these superficial injections is more or less satisfactory. Very often the first successful injection will give relief for months, but it is our observation, from the histories of a number of cases that had repeated superficial injections, that, while the first injection may have given relief for a considerable period of time, later, the time of relief given shortens until at last they are practically ineffective. The longest period of relief that we have known, following a superficial injection, is a year. When it is demonstrated that superficial injections no longer give relief, then the deeper nerve trunks must be attacked. It is our custom, when the diagnosis is established, to at once make the deep injections which give a much longer period of immunity. According to our observations, the relief from apparently successful deep injections varies from one year to

indefinitely. Therefore we feel justified in the statement that, with the exception of the first division, deep injections should be tried in all cases before the more radical intracranial operation is advised.

Supraorbital neuralgia may be attacked by alcoholic injection of the supraorbital nerve at the supraorbital notch, which can be felt at the junction of the inner with the outer two-thirds of the upper border of the orbit.

**Deep Injections of the Trunks of the Fifth Nerve.**—Injection of Third, or Mandibular Division.—The needle enters 5 or 10 millimeters below the middle of the zygoma and half way between

Fig. 312.—The posterior dotted line on the pterygoid process shows the path followed by the point of the needle in the injection of the third division, after it has encountered the pterygoid process. The anterior line shows one course taken in reaching the second division.

the posterior border of the condyle of the jaw and the angle formed by the temporal and zygomatic border of the malar bone. It penetrates to a depth of 40 to 50 millimeters and then comes in contact with the external plate of the pterygoid process. This depth varies in proportion to the width of the skull and the prominence of the cheek bones. The average depth at which the process will be encountered is about 43 millimeters, and it is not commonly over 45 or under 40 millimeters, although in a few cases it may vary considerably beyond these limits. If the needle penetrates deeper than would be expected from the size and contour of the skull without

striking the process, it should be withdrawn somewhat and thrust slightly upward and forward, for it may have passed behind the process. When the bone of the process is felt, the point of the needle is worked upward repeatedly, withdrawing slightly, and then reinserting it, the point each time coming in contact with the bony plate, until the under surface of the great wing of the sphenoid is felt. This surface is rather perpendicular to the pterygoid process, and the needle is felt to slide obliquely along the bone. In this way the sulcus between the pterygoid process and the under surface of the sphenoid wing is located. When this sulcus is recognized, the point of the needle is, by the same process of withdrawing and reinserting, made to step backward until it is felt to slip off into the space at the posterior border of the process, when it will be right at the foramen ovale, which gives exit to the whole of the third division of the fifth nerve. In working the point of the needle backward, it is kept more in contact with the under surface of the sphenoid wing than with the external plate of the process. The sulcus between these two is rounded, and the needle must work along the upper part of the groove. Otherwise, when the posterior border of the process is reached, the point will be below the foramen ovale, and a backward projection of the external pterygoid plate might separate it from the nerve (Fig. 312).

When from the feel of the needle or the sensation of the patient it is thought that the needle is in contact with the nerve, the fluid is liberated a few drops at a time, the point of the needle being shifted slightly, until an anesthesia and a paresthesia proclaim the success of the injection, or until 4 cubic centimeters of the alcohol mixture or 25 cubic centimeters of Weiner's fluid are liberated. Special effort should be made to obtain an anesthesia at the site of the pain spot.

At the time the injection is made, the depth of the needle point should not be more than 5 millimeters greater than it was when the external pterygoid plate was first struck. If driven deeper than this, the Eustachian tube, which lies just internal to the foramen ovale, might be injured.

Injection of Second or Superior Maxillary Division.—This is injected by inserting the needle below the zygoma at the junction of the anterior with its posterior two thirds. It may be that the coronoid process of the jaw will be encountered, and if this is the case, the mouth must be held open with a gag or by placing a folded napkin or a cork between the anterior teeth or gums.

The external pterygoid plate is encountered at an average depth of 43 millimeters, depending on the size of the skull and the prominence of the zygoma. In twenty-two dried skulls the depth varied from 33 to 50 millimeters. When the external pterygoid plate is found, the point of the needle is made to step upward and forward until it is felt to drop into the sphenomaxillary fossa, when it will be in close proximity to the nerve sought, and also to the sphenopalatine (Meckel's) ganglion. In quite a large number of skulls there is a sharp outward flare of the anterior border of the external pterygoid plate just where it is crossed by the needle. If this is encountered, the needle must be drawn sufficiently to step over this obstruction. The needle, when in the fossa, should not have penetrated more than 5 millimeters deeper than it was when it first struck the surface of the pterygoid plate. On entering the fossa, the needle is directly in line with the sphenopalatine foramen of the palate bone and could penetrate into the cavity of the nose without encountering any bony obstruction. In this regard the rule that has been suggested, to insert the needle in a direction upward and forward and make the injection at a depth of 50 millimeters, might in some skulls lead one to make the whole injection directly into the nasal fossa. This injection of the second division is more difficult than that of the third. If for some reason the nerve is not located by the directions given, the needle may be made to travel still farther forward until the posterior surface of the superior maxillary bone is encountered, and then to travel upward as far as possible where the nerve is encountered, lying in a shallow groove on the upper posterior part of the maxillary bone (Fig. 312). If, in doing this, the needle is inserted too deeply, the injection may be made into the orbit through the sphenomaxillary fissure. In attempting this in a skull that is affected with osteoporosis, the injection might be landed in the antrum (Fig. 313). We have had this accident happen once.

Injection of the Sphenopalatine Ganglion.—In view of Sluder's work on neuralgia associated with irritations near the sphenopalatine (Meckel's) ganglion, it is desirable to have a definite technic for reaching this ganglion. Sluder has been in the habit of injecting this ganglion through the nose by piercing the vertical plate of the palate bone, but with an operator less skilled, this would be a very uncertain mode of approach. Dr. Sluder and the writer have made a study of the practicability of an external approach. When the needle is inserted, as advised above for reaching the second division,

the point of the needle usually stops in front of, or external to, the ganglion. It may be inserted just below the malar bone at a point directly below the angle between the temporal border of the malar bone and the upper border of the zygoma. The needle is pushed slightly upward and a very little backward until the pterygoid process is encountered. The needle is then slipped forward until it enters the sphenomaxillary fossa. The injection is made while moving the point of the needle up and down in the fossa, at a depth of 5 millimeters greater than that at which the point was

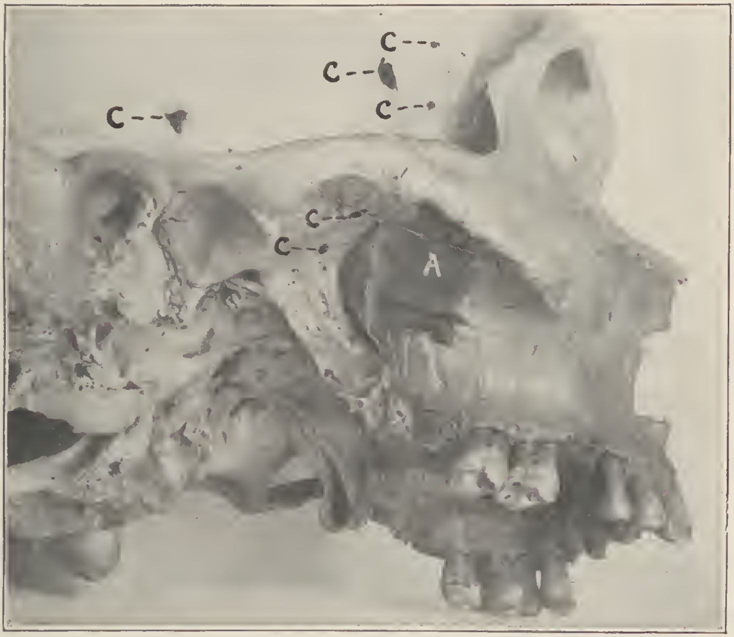



Fig. 313.—Skull showing osteoporosis. A, defect in outer wall of antrum. C, openings into the cranial cavity.

when it encountered the pterygoid process. The mouth should be wide open. The success of this injection is determined by the anesthesia developed over the hard palate and within the nose over the turbinate bones and septum.

The immediate effect of a successful injection with the alcohol formula (page 468) is a very severe pain radiating over the distribution of the nerve, which is usually quickly followed by an anesthesia and a subjective numbness, or possibly only the latter, but in either case the neuralgic pain is at once completely relieved (Fig.

314). There will be paresthesia, in the form of crawling sensations over the distribution of the affected nerve, and a sensation of stiffness over that side of the face. Complete and rather persistent loss of taste and also a weakness of the muscles of mastication on that side often follow the injection of the third division. With the alcoholic injections there is a slight swelling of the face that may last several days. There is often a little fever that may at first go to 102° or 103°, but we have never seen any serious inflammatory condition result. In a few days most of the anesthesia will have disappeared (Figs. 314 and 315), but traces of it will remain for six months to a year. The paresthesia may last longer. In 75 per cent of the cases the pain had not returned, when last heard from at periods varying from several months to five years, and all had experi-

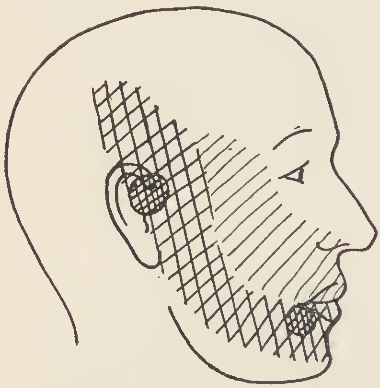


Fig. 314.

Fig. 315.

Fig. 314 shows the anesthesia after injection for neuralgia of the second and third division. The second division was injected on March 2, 1909, with almost total anesthesia resulting. The third division was injected March 24, 1909. It was charted on March 25, 1909. It will be seen that the anesthesia to pain and touch over the second division has considerably lessened between the time of injection and the time of charting. At the time of charting it was found that on the right side, the lingual and labial surfaces of the lower gum, the superior, inferior, and lateral surfaces of the anterior two thirds of the tongue, and the internal surface of the cheek below the occlusal line were completely anesthetic to touch, pain, and temperature and sense of taste was lost in the anterior two-thirds of the right half of the tongue.

Fig. 315 shows the area on the surface that was completely anesthetic to heat and cold. The anesthesia had not entirely disappeared nine months after the injection. Pain had persisted for fifteen years before injection, and had not returned one year after injection.

enced some benefit from the operation. If the operation proves unsuccessful, the injection may be repeated as soon as the reaction subsides. The patient can be assured that the second injection will not be as painful as the first, at least not until the nerve is actually struck; and then the pain may be over in a few minutes. Sometimes

it is more persistent. A number of patients have returned for reinjection at periods mostly between fifteen months and two and one half years. So far, these have experienced relief from the second injection, but it is possible that a time may come in many cases when the injection will no longer be efficient and that a ganglion operation may eventually be necessary.

It is always well to start with the understanding that it may require more than one injection to cure the pain. When the two divisions are involved, they may be injected at the same sitting if the patient stands it well; but the most painful branch should be treated first. Sometimes the injection of one division will be followed by relief of a pain spot that was situated over the distribution of another division, but often the neuralgia in the least affected nerve will become apparently worse after its more severely affected neighbor has been relieved. The second and third can often be injected with one insertion of the needle, entering it as for the injection of the third division, and when that injection is made, shifting it forward to the second.

**Intracranial Operations.**—If the attack upon the peripheral nerves proves primarily or ultimately a failure, then, to obtain relief, the interruption in the sensory conduction tract must be made at or proximal to the Gasserian ganglion.

In 1884, W. J. E. Mears first proposed the removal of the ganglion for tic douloureux, and in 1890, Rose performed the first successful operation. In 1891, Horsley, failing to remove the ganglion, avulsed the sensory root. The complete extirpation of the ganglion is an extremely difficult operation, and one attended by very profuse and unavoidable hemorrhage.

The difficulty and danger encountered in separating the ophthalmic division from the wall of the cavernous sinus are such that Hutchinson has been led to abandon this part of the ganglion and to content himself with the removal of the parts related to the second and third division. In many cases, however, the first division is affected or becomes so later, and in a number of failures after supposed complete removal, it is in the distribution of the ophthalmic that the pain has returned.

The section or avulsion of the posterior root of the ganglion is a simpler operation, and is freer from hemorrhage. It is productive of less shock, and in doing it, one may be certain that all connection with the higher perceptive centers has been destroyed. It is probable that the ganglion has some trophic functions that are not inter-

fered with by the posterior root section; therefore the operation of extirpation of the ganglion is being replaced by some operators for that of the posterior root section. Spiller first urged this as the operation of election, and Frazier has performed it probably more often than any one else. The only objection that can be urged against the latter operation in favor of the former is that in a certain percentage of cases the skillful operator can preserve the motor root intact while extirpating the ganglion, which is almost impossible to do while simply cutting the posterior root.

The mortality from the more recent ganglion operations in the hands of experienced operators is less than 4 per cent. Frazier reports one operative fatality in 177 consecutive posterior root sections. In ganglion extirpation most of the deaths have occurred within the first twenty-four hours after the operation from shock or hemorrhage, both of which are less in the root operation than in the extirpation.

The effects of the operation are paralysis of the muscles of mastication in the affected side when the motor root is cut, and an absolute anesthesia over the areas that are supplied wholly by the fifth nerve.

Ulceration of the cornea is a common postoperative complication of the removal of the ganglion, but according to Spiller, it is not so frequent after posterior root section. The eye should be protected by a transparent shield for several weeks after the operation, and the possibility of corneal ulceration should not be dismissed till after three months have elapsed. It is very probable, but not absolutely certain, that posterior root section will cure every case of tic douloureux.

## CHAPTER XXIX

## ANESTHESIA

Proper selection of the form of anesthesia and the anesthetic agent to be employed in any given case is of the utmost importance. In this chapter will be considered the various methods which have been found most suitable for operations upon the face, mouth and jaws.

Anesthesia may be taken up under two broad general headings, local anesthesia, and general anesthesia. *Local anesthesia* is produced by inhibiting the sensory nerve fibers of a part either in their course or at their peripheral end-organs, the individual retaining full consciousness. *General anesthesia* or narcosis is a state of unconsciousness with general loss of sensation, induced by various agencies introduced into the organism, usually by inhalation.

### LOCAL ANESTHESIA

Superficial and transient local anesthesia may be produced by refrigeration of the tissues. Ethyl chlorid is the most satisfactory agent for this purpose (Fig. 316). For the extraction of teeth and any minor operation about the head and oral cavity, the capillary end of the tube should be held about six to ten inches from the part

Fig. 316.—Ethyl chlorid tube.

to be sprayed. The Gebauer tube is fitted with a spray nozzle, which shortens the distance to one or two inches, and is especially well adapted for dental purposes. The part should be sprayed until the tissues are covered with ice crystals and have turned white. The tissues to be anesthetized should be dried well, and the adjacent tissues should be rubbed with vaselin or glycerin. If the stream is to be directed to some part within the mouth, cotton rolls and gauze should be packed around, to prevent the liquid from running down

the throat. For the extraction of teeth the liquid should be projected directly upon the surface of the gum, as near the apex of the root as possible, but care should be taken to protect the crown of the tooth on account of the painful action of the cold on this part. On account of the difficulty of directing the stream of ethyl chlorid upon the tissues in the posterior part of the mouth, it is not successfully applied in these regions.

Under ordinary conditions, the use of the ethyl chlorid spray is limited to anesthesia for opening superficial abscesses.

**Production of Local Anesthesia by Injection.**—Various substances have been introduced from time to time to paralyze sensory nerve endings by injection into the tissues. Cocain hydrochlorid, beta-eucain hydrochlorid, alypin, stovain, novocain (procain), and quinin and urea hydrochlorid are the best known of these, used in solutions ranging from one-half to five per cent. Novocain or procain has practically replaced cocain and all of the other substances mentioned. It is efficient and is only about one-seventh as toxic as cocain, so that in the usual strength employed, practically unlimited quantities of the solution can be used without toxic effects. Procain is not a habit-forming drug, the solution can be sterilized by boiling, which is not true of cocain without interference with its anesthetic properties. For most practical purposes solutions of procain ranging from ½ to 2 per cent are employed. With the procain is combined adrenalin chlorid or suprarenin in the proportion of one part in about ten thousand. The adrenalin enhances and prolongs the anesthetic effect, constricts the blood vessels of the part, thus lessening hemorrhage, and retards absorption of the anesthetic.

Cocain is still largely employed in operations on the nasal cavity by topical application of a 10 per cent solution. This is introduced by means of gauze packing soaked in the solution, held in contact with the mucous membrane for several minutes, after which the operation may proceed. Cocain in the same strength is also used by instillation to paralyze sensation of the cornea in ophthalmic operations. There is no justification for the use of cocain at the present time to produce local anesthesia by infiltration.

**Local Anesthesia for Extraction of Teeth and Operations about the Jaw Bones.**—With improvements in technic and the substitution of procain for cocain, what was formerly condemned as dangerous and unsatisfactory, has at the present time come to be regarded as one of the most valuable aids in dental and oral surgery. The essentials of success in the employment of local anesthesia in this

field as elsewhere are a thorough knowledge of the anatomy of the parts, proper technic, the selection of suitable cases, and, above all, the observance of rigid asepsis.

**Contraindications.—**

(1) *Inflammation.*—It is dangerous to inject a local anesthetic into acutely inflamed tissues, as the introduction of any fluid under pressure in these circumstances may result in spreading the infection or sloughing of the tissues. The anesthetic effect, too, is not nearly so powerful when the tissues are inflamed.

(2) *Trismus.*—In operations within the mouth, contracture of the muscles of mastication by inflammation or irritation may make it impossible to get the mouth open wide enough to inject the anesthetic.

(3) *Nervous Individuals.*—Certain people of nervous temperament are not suitable subjects for local anesthesia, their condition causing them to flinch at the sight of instruments, the prick of the needle, etc. By judicious handling, the operator may gain the confidence of many of these patients, and succeed in working under local anesthesia.

(4) In *young children*, the same objections apply to local anesthesia as in nervous adults. In these cases general anesthesia is indicated.

With these exceptions, local anesthesia is usually preferable for the extraction of teeth, root resection, cyst operations, alveolectomy, removal of sequestra, extirpation of small tumors, suturing of wounds, plastic operations.

**Anatomy of the Jaws and Teeth in Relation to Local Anesthesia.** —Under no other circumstances is a knowledge of the anatomy of the parts, especially of the nerve supply, more essential than in the use of local anesthesia. The anatomical features of the upper and lower jawbones which are of especial importance in local anesthesia will first be taken up, after which the nerve supply of the parts will be considered.

The *osseous structure* of the maxilla and mandible is composed of outer cortical or dense bone and inner cancellated or spongy bone. The denser the bone the more difficult the penetration of the anesthetic solution. The anesthetic is carried through the outer cortical plate to the spongy bone and roots of the teeth within, through minute openings or canaliculi which are found in variable numbers in different parts of the bony surface. As a general rule, there are more of these canaliculi in the maxilla than in the mandible, rendering infiltration anesthesia correspondingly easier in the former. In the

anterior portion of the mandible, around the incisor, canine and premolar teeth, the cortical bone is, as a rule, not so dense as around the molars, where the bone is very dense and anesthesia by infiltration difficult to obtain. In some cases, following chronic inflammation, the bone becomes particularly solid from a deposit of calcium salts, and the anesthetic solution will not penetrate at all.

The *dental alveoli* are crater-shaped depressions in the cancellated substance of the bone, containing the roots of the teeth. The individual alveoli are separated by septa, consisting of thin and porous lamellae and of spongy tissue between the lamellae. The walls of the alveoli possess fine cribriform perforations, which permit of rapid

Fig. 317.—Anterior aspect of maxilla, showing position of needle for injection at infraorbital foramen.

diffusion of the anesthetic solution, which in this manner reaches the nerve endings in the peridental membrane.

**Foramina and Bony Landmarks in the Maxilla.**—On the *anterior aspect* of the maxilla, just behind the canine tooth is a depression—the *canine fossa*—which leads up to the *infraorbital foramen,* situated about 1 cm. below the middle of the lower margin of the orbit and above and between the roots of the first and second premolars. This foramen transmits the infraorbital branch of the second division of the fifth nerve, and the infraorbital vessels (Fig. 317).

On the *palatal surface* of the maxilla are found the posterior palatine foramen and the incisive fossa or anterior palatine fossa (Figs. 318 and 319).

The *posterior palatine foramen* is situated opposite the third molar

Fig. 318.—Palatal aspect of maxilla, showing position of needle for injection at incisive fossa.

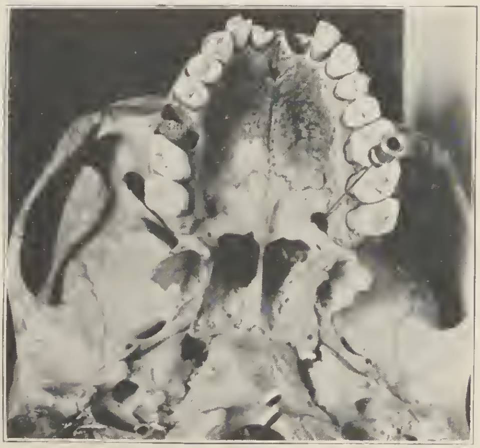


Fig. 319.—Palatal aspect of maxilla, showing position of needle for injection at posterior palatine foramen.

tooth, about 1 cm. toward the median line. It transmits the anterior palatine nerve, a branch of Meckel's ganglion. This nerve, after leaving the foramen, passes forward in a groove parallel with the molar teeth, accompanied by the posterior palatine vessels.

The *incisive or anterior palatine fossa* is a depression in the median line in the anterior portion of the hard palate just behind the central incisor teeth. In this fossa are four openings, two being the foramina of Scarpa, situated antero-posteriorly, and transmitting the naso-palatine nerves, and two situated laterally, the foramina of Stenson, transmitting the anterior palatine vessels.

On the *posterior aspect* of the maxilla is seen the rounded *tuberosity,* in the upper portion of which are found small foramina admitting the superior alveolar or superior dental vessels and nerves (Fig. 320).

Fig. 320.—Showing position of needle for injection at tuberosity of maxilla.

**Foramina and Bony Landmarks of the Mandible.**—Below and between the roots of the lower premolar teeth is found the *mental foramen,* which transmits the mental nerve and vessels. (Fig. 321).

In adults the ascending ramus of the mandible begins a little behind the third molar, and passes up almost at right angles to the body of the bone. At the lower part of the ascending ramus, there are seen an outer ridge, which is a continuation of the *external oblique line,* becoming continuous above with the anterior edge of the coronoid process. About 0.5 cm. inward and back of this is another ridge, the *internal oblique line,* which gradually loses itself in the coronoid process. Between these two ridges and the third molar tooth in front is a more or less triangular depression—the *retromolar triangle or fossa.* This fossa is not directly behind the third molar in a sagittal plane,

but lies rather posteroexternally. It serves as the most reliable landmark to the palpating finger in injecting at the inferior dental foramen. (Figs. 322, 323, and 324.) The ascending ramus, when the mandible is viewed from above, diverges from the median line, form-

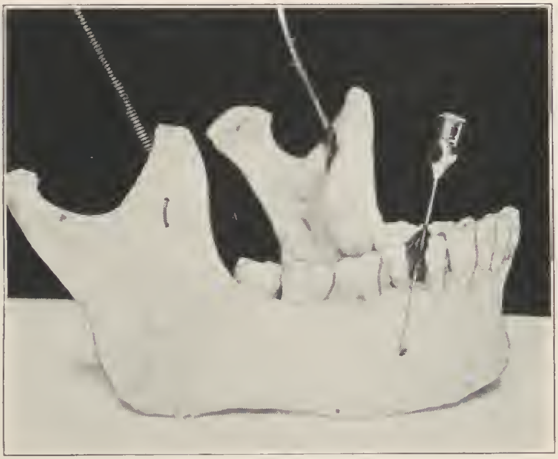


Fig. 321.—Outer aspect of mandible showing position of needle for injection at mental foramen.

Fig. 322.—First position of needle at internal oblique line, for injection at mandibular foramen.

ing an obtuse angle with the posterior portion of the body of the bone.

The *inferior dental or mandibular foramen* is a large opening situated about the central point of the internal surface of the ascending ramus of the mandible, and transmits the inferior alveolar or inferior

dental nerve and vessels (Fig. 324). This foramen marks the beginning of the mandibular canal or tube, which passes forward through the body of the bone to terminate at the mental foramen.

Below the mandibular foramen begins the mylohyoid groove which

Fig. 323.—Second position of needle in mandibular injection. Point of needle is in region of lingual nerve. Barrel of syringe rests on premolar teeth of opposite side.

Fig. 324.—Third position of needle in mandibular injection. Point of needle is in mandibular sulcus, just above and behind mandibular foramen.

runs obliquely downward and forward and transmits the mylohyoid vessel and nerve. Directly anterior to the foramen, and projecting backward, is a bony spine, the *lingula*. In adults, the mandibular foramen is situated about the level of the occlusal surfaces of the

lower molar teeth. The mandibular foramen is continued posteriorly and upward in the form of a shallow groove or depression—the *mandibular sulcus*—about 2 cm. in diameter, which forms the external boundary of the *pterygomandibular space* (Fig. 324). The internal pterygoid muscle forms the inner boundary of this space, which is filled with connective tissue, and through which pass the internal maxillary artery, the inferior alveolar vessels and nerve, and the lingual nerve. The inferior alveolar nerve lies anteriorly and mesially to the vessels, and the lingual nerve is still more anterior.

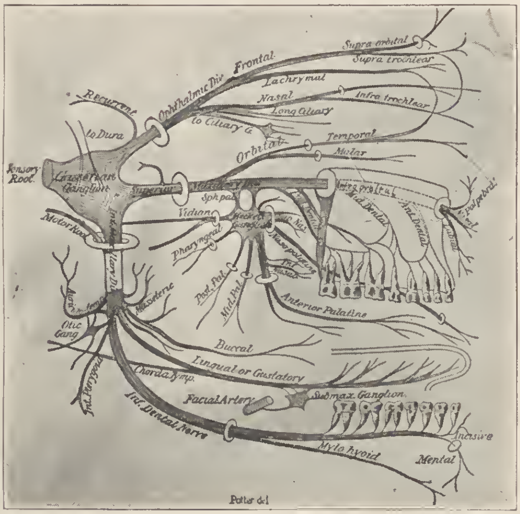



Fig. 325.—Diagram of trigeminal nerve. (From Quiz Compend of Anatomy—Potter. By permission of P. Blakiston Co.)

**Nerve Supply of the Teeth and Jawbones.**—The sensory innervation of the upper and lower jaws is entirely through the fifth or trigeminal nerve (Fig. 325). The deep origin of the trigeminal is from a motor nucleus and a sensory nucleus in the floor of the fourth ventricle. The superficial origin is from the side of the pons Varolii, where the nerve emerges as a small anterior motor root and a larger posterior sensory root. The sensory root terminates in the Gasserian ganglion. The motor root passes out of the brain case through the foramen ovale and joins the sensory portion of the mandibular division immediately outside this foramen.

The *Gasserian ganglion* is a crescent-shaped structure, with its convexity directed forward, situated in a depression at the apex of the

petrous portion of the temporal bone. The ganglion is connected posteriorly with the sensory root of the trigeminal nerve.

The branches of the Gasserian ganglion, three in number, are given off from its anterior aspect and are as follows:

First, or ophthalmic, division of trigeminal nerve.

Second, or maxillary, division of trigeminal nerve.

Third branch, which unites with the motor root to form the mandibular division of the trigeminal nerve.

The *ophthalmic* division passes forward along the outer wall of the cavernous sinus, passes through the sphenoidal fissure into the orbit, and breaks up into three branches, lachrymal, frontal, and nasal. The ophthalmic division does not concern us in local anesthesia of the teeth and jawbones.

The maxillary and mandibular divisions are of great importance in this connection.

The *maxillary* division passes forward from the Gasserian ganglion, and leaves the cranium through the foramen rotundum. It crosses the sphenomaxillary fossa, and enters the orbit through the sphenomaxillary fissure. The nerve then becomes the infraorbital, enters the infraorbital canal in the floor of the orbit, and runs forward to open on the face at the infraorbital foramen, where it breaks up into its terminal filaments. The branches of the maxillary nerve of importance in local anesthesia of the upper teeth and jaw are, the sphenopalatine, the superior alveolar or superior dental, and the infraorbital. The *sphenopalatine* branches, two in number, are given off in the sphenomaxillary fossa and pass to Meckel's ganglion, forming its sensory root. *Meckel's ganglion,* also known as the sphenopalatine ganglion, is situated in the sphenomaxillary fossa, below the maxillary division of the trigeminal nerve. Among its branches are the *anterior palatine nerve,* which descends through the posterior palatine canal, emerges on the hard palate at the posterior palatine foramen opposite the third molar tooth, and runs forward to supply the mucous membrane of the hard palate as far forward as the canine tooth, where it interlaces with filaments of the naso-palatine nerve. Another branch is the *naso-palatine nerve,* which runs forward along the roof of the nose, crosses the septum, then passes down the naso-palatine canal to open in the incisive fossa in the anterior portion of the hard palate through the foramen of Scarpa. This nerve conveys sensory impulses from the mucous membrane of the anterior portion of the hard palate.

The *superior alveolar or superior dental nerve,* sometimes also called

the posterior dental nerve, is given off in the spheno-maxillary fossa, and passes through openings in the posterior surface of the tuberosity of the maxilla to send filaments to the upper molar and sometimes premolar teeth. There is a good deal of dispute as to the exact manner in which the premolar teeth are supplied. It is claimed by some that they receive their sensory innervation through a distinct branch coming down from the infraorbital canal, the middle superior dental, at any rate, in a large percentage of cases it is difficult or impossible to obtain anesthesia of the premolar teeth by injecting the superior alveolar nerve as it enters the tuberosity, supporting the view that these teeth are supplied by a separate branch at least in some cases.

The *infraorbital nerve* is the terminal branch of the maxillary division of the trigeminal. It lies in the infraorbital canal, and opens on the face at the infraorbital foramen, where it breaks up into its terminal branches, which supply the skin of the region, also the mucous membrane of the upper lip and anterior portion of the gums. The infraorbital nerve sends the anterior dental branch down in the anterior wall of the maxillary sinus, which supplies sensation to the canine and incisor teeth of the upper jaw and the muco-periosteum of the maxillary sinus. In a certain percentage of cases the middle dental branch is given off in the infraorbital canal and supplies the premolar teeth.

From the foregoing, it is seen that the nerve supply of the upper teeth and surrounding bone and soft tissues may be divided into two loops, an outer derived from the superior alveolar and infraorbital branches, supplying the upper teeth and outer aspect of the gums, and an inner loop, derived from Meckel's ganglion, supplying the hard palate and inner aspect of the gums through the anterior palatine and naso-palatine nerves.

The *mandibular division* of the trifacial nerve is its largest branch. It is formed by the junction of the third portion of the sensory root from the Gasserian ganglion with the motor root. The two leave the cranium separately through the foramen ovale, and unite immediately afterward to form one trunk. About a quarter of an inch lower down, behind the external pterygoid muscle, the trunk branches into a small anterior and a large posterior division. The branches of the anterior division are chiefly motor to the muscles of mastication, with one exception, viz., the long buccal, which supplies sensation to the mucous membrane of the cheek and the outer side of the gums of the lower molar teeth.

The two principal sensory branches of the mandibular nerve are the lingual and the inferior alveolar or inferior dental.

The *lingual nerve* runs downward and forward on the internal pterygoid muscle to the inner side of the lower jaw, above and in front of the inferior alveolar branch, on a line midway between the third molar tooth and the angle of the mandible. It runs forward to the tip of the tongue. This nerve supplies common sensation to the tongue, the floor of the mouth, and to some extent the inner surface of the gums of the lower teeth.

The *inferior alveolar* or *inferior dental nerve* passes downward and enters the mandibular canal through the inferior dental (mandibular) foramen. It passes forward toward the symphysis menti, sending an incisive branch to the incisor teeth, and opens on the face as the mental nerve at the mental foramen. By its dental and gingival branches this nerve supplies sensation to the lower teeth, gums and alveolar process. After emerging through the mental foramen, between and below the roots of the lower premolar teeth, the mental nerve breaks up into filaments which supply the skin of the chin and lower lip.

**Summary of Areas of Nerve Supply or Masticatory Apparatus.**—In the *maxilla,* the anterior teeth and surrounding alveolar process and gums are supplied by the anterior dental branch of the infraorbital nerve. The molar and premolar teeth are supplied by the posterior and middle dental. There are two sources of innervation of the hard palate, the anterior portion, just behind the upper incisors, from the naso-palatine nerve, and the posterior portion, as far forward as the canine tooth, from the anterior palatine nerve, both of these being branches of Meckel's ganglion.

In the *lower jaw,* all of the teeth and alveolar process are supplied with sensation by the inferior alveolar nerve. In the median line in front, the nerves from the two sides overlap to some extent.

The outer side of the gum in the molar and premolar regions is innervated partly by the long buccal nerve, while on the inner side of the gum, sensation is conveyed in part by the lingual nerve.

**Preparation of Patient for Local Anesthesia.**—For minor dental operations, as a rule, no preliminary preparation is necessary. In nervous or excitable individuals, or when a long operation is anticipated, a hypodermic injection of $\frac{1}{6}$ grain of morphine and $\frac{1}{150}$ grain of atrophine half an hour before injection of the anesthetic has a soothing effect. It is not necessary to purge the patient or withhold food and water before operations under local anesthesia.

**Preparation of the Field of Injection.**—Before injecting the local anesthetic solution into the mucous membrane, the latter is carefully dried and sterilized by painting with a solution consisting of equal parts of tincture of iodin and ether. This is superior to plain tincture of iodin as it dries more quickly and does not have so marked an escharotic effect. After painting the part, nothing is allowed to touch it until the needle is inserted, nor is the part permitted to become moistened with saliva. The practice of painting the part with iodin and then allowing it to become contaminated with saliva or contact with the opposing mucous membrane of the lip or cheek defeats the purpose of the iodine application, which is to kill any bacteria that may be on the surface. It is convenient to employ a wooden applicator mounted with cotton at each end, one end serving to dry the mucous membrane and the other to apply the iodin solution.

**Preparation of Solution, Syringe, Etc.**—The most important feature here is the observance of rigid asepsis. Simplicity of armamentarium and aseptic technic form the keynotes of success. The insistence on freshly distilled water, Ringer's solution, special porcelain dishes, needle guards, and other paraphernalia only complicate the procedure and tend to frighten off the average practitioner and make him think the method is something beyond his reach. All of these refinements may be dispensed with, although each may have a theoretical justification. A steel needle is just as good as one of iridio-platinum as long as it is sterilized by boiling. Ordinary boiled water, rendered isotonic by the addition of sodium chloride in the proper amount is absolutely harmless. Normal salt solution has been used in this way for several decades in hospitals for subcutaneous infusions of 1000 c.c. or more without damage to the tissues. The solution can be sterilized by boiling just as well in an ordinary tablespoon as in a fancy porcelain container. More emphasis should be placed upon sterilization and cultivation of the sense of asepsis and less on any special armamentarium. Only syringes that can be sterilized by boiling should be used. The keeping of syringes in solutions of alcohol and glycerin or other chemical methods should not be relied on for sterilization. One can never be certain that the interior of the syringe is sterile under these conditions. One important point is that the glass bottles containing the novocain and particularly the adrenalin solution should be alkali-free, as the slightest trace of alkali will decompose the adrenalin and to some extent the novocain. For this reason syringes, bottles, and other paraphernalia should be boiled

in plain water, and not in water containing soda. The bottles should be brown in color, as light has a decomposing effect.

**Novocain Solution.**—Ordinarily, we employ a 1.5 per cent solution of novocain (procain) in normal salt solution. This solution can be made up in quantity and kept in a stock bottle for about two weeks without deterioration. A convenient quantity for office use may be prepared from the novocain D tablets, which contain sodium chloride. One D tablet dissolved in water will make 15 c.c. of a 1.5 solution of novocain in normal salt solution. This will usually be sufficient for one or two days' use in the office. Adrenalin chloride is kept separately in 1-1000 solution in a brown dropping bottle and is not added to the novocain until just before use, thus avoiding deterioration. The amount of adrenalin employed can in this way be varied according to the individual case. Ordinarily, we employ about one drop of the

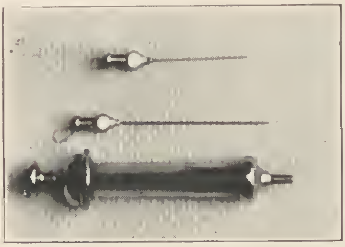


Fig. 326.—Record syringe and needles used in local anesthesia. The longer needle, 22 gauge, 1½ inches long is used for conduction anesthesia, and the shorter needle, 24 gauge, 1 inch long, is used for infiltration.

adrenalin solution to every 2 c.c. of novocain solution, sometimes much less, and never more.

**Syringe and Needles.**—The simplest, cheapest and most suitable syringe for the purpose we have found to be the ordinary 2 c.c. Record syringe, obtainable at any surgical supply house and universally used in hospitals (Fig. 326). Objection has been made that the needle slips on instead of screwing on and that sufficient pressure cannot be obtained without the needle coming off. This is really an advantage, because pressure sufficient to force off the needle is also liable to damage the tissues. The Record syringe can readily be taken apart and boiled before use, thus insuring sterility.* Two lengths of needles are employed. For deeper injections, such as blocking the inferior dental nerve at the mandibular foramen, a one and a half inch, 22-

*In sterilizing a new Record syringe, after taking it apart it should be placed in cool water which is then brought to boiling point. After sterilization has been performed a few times in this way, the syringe after being taken apart can safely be placed in boiling water at the start.

gauge needle is used. For infiltration, we employ a 24-gauge needle, one inch in length. Both are made of steel, and have no guard (Fig. 326). By using a 22-gauge needle, the danger of breakage is greatly lessened, and yet the caliber is not sufficiently great to produce an unduly large puncture. The special needles provided with guards are just as liable to break beyond the guard as between the hub and the guard.

## Technic of Induction of Local Anesthesia

**Infiltration Anesthesia.**—A limited area of the alveolar process may be anesthetized by injecting the solution under moderate pressure into the periosteum through the oral mucosa. This method may therefore be termed *periosteal infiltration.* The anesthetic effects are immediately due to contact of the anesthetic fluid with the sensory nerve endings of the part injected. Complete anesthesia should occur within from five to ten minutes, and remain for about half an hour. Infiltration anesthesia is suitable for the extraction of individual teeth, with the exception of lower molars, and also for minor operations confined to limited areas.

For infiltration of a limited area about one tooth, the short one inch needle is employed. The lip is raised with the left hand, and the part to be injected is dried and painted with the iodin-ether solution. The syringe is held in the right hand like a pen, and the needle placed against the gum surface almost at right angles to it, with the bevelled edge of the needle facing the bone. The needle is then slowly pushed through the gum tissue down to the periosteum, the needle being inclined to form an acute angle with the bone. The correct quantity of solution, usually from 0.5 to 2 c.c. is then injected slowly without advancing the point of the needle farther along the bone. The injection is made slowly and with as little pressure as possible. The needle is then withdrawn, and the fluid diffused by pressure over the point of injection for a few seconds with the index finger.

**Maxilla.**—For extraction and operations on upper teeth, injections are made both on the labial or buccal and palatal surfaces. On the buccal or labial surface, the injection is made in the manner described, the point of the needle entering the gum about the junction of the apical and middle thirds of the root of the tooth. Repeated insertions of the needle should be avoided as much as possible, and an effort be made to infiltrate the desired area with one insertion, which is always possible in single-rooted teeth. The injection even for several adjoining teeth can be accomplished with one buccal insertion, especially in premolars and molars, by the horizontal advancement of

a long one and one-half inch needle. In this case the needle is inserted at the level of the middle of the roots at right angles to the long axes of the teeth. On the palatal surface the needle is inserted in the mucosa opposite the tooth to be operated on and its point carried to the alveolar process over the region of the apex. A smaller amount of fluid (0.25 c.c.) is usually sufficient here.

**Mandible.**—In the mandible infiltration anesthesia is limited to the incisors, canines, and premolars, though even with these teeth, when several are to be extracted or operated upon, conduction anesthesia is recommended. On the labial surface, the most favorable point of injection is near the gingival margin, because here the underlying alveolar process is perforated by short canals which conduct the solution to the sockets of the teeth. Lingually, a small quantity of solution is injected behind the central incisors and in the line of their long axis, also between the canine and first premolar, in order to anesthetize the filaments of the lingual nerve.

In the region of the lower molars, conduction anesthesia alone is indicated, as the anesthetic fluid will not penetrate the dense process around these teeth.

Particular care must be exercised in injecting about infected areas. Conduction anesthesia should always be used when possible in these cases. If infiltration is to be used, the injection must always be made in healthy mucous membrane in the vicinity of the focus of infection. The needle should not be advanced toward the focus in these cases, and several injections around the focus of infection may be necessary.

**Summary of Technic of Periosteal Infiltration.**—Besides the precautionary measures in preparation of solution, sterilization of syringe and needles, and observance of asepsis, the following are the principal points to be followed for successful periosteal infiltration:

(1) Sterilization of mucosa with iodin solution.

(2) Insertion of the needle directly to the periosteum before making the injection.

(3) Deposit of the necessary amount of fluid on the buccal and palatal surfaces.

(4) See that the bevelled edge of the needle is toward the bone.

(5) Slow, steady, moderate pressure during the injection.

(6) Compression of the point of injection with the finger after withdrawal of the needle.

(7) Waiting period of 3 to 5 minutes.

## Conduction Anesthesia

When injected in the vicinity of a nerve trunk, an anesthetic solution penetrates by way of the perineurium into the central nerve substance, inhibiting its conducting function, and thus anesthetizing the entire peripheral area supplied by the nerve. Conduction anesthesia is therefore anesthesia produced by elimination of the conductivity of the nerve trunk. In inducing anesthesia in this manner, it is doubtful whether the needle often actually penetrates the nerve sheath. The injection is made in the region of the nerve and the solution then is absorbed through the perineurium. This form of anesthesia may therefore be termed perineural anesthesia.

The advantages of conduction anesthesia over infiltration anesthesia may be summed up as follows (Blum):

(1) Its long duration.

(2) With one or two injections and less of the anesthetic large areas are anesthetized.

(3) The infiltration of infected areas can be avoided.

(4) The procedure is even less painful, because the solution is injected without pressure and into loose tissues.

**Conduction Anesthesia in the Maxilla.**—In conduction anesthesia of the upper jaw, the two nerve loops previously mentioned must be taken into consideration, the outer, formed by the infraorbital and superior alveolar or superior dental nerves. This loop supplies the bone and all of the teeth of the upper jaw on one side, the mucous membrane of the maxillary sinus, and the buccal periosteum and gum tissue. The inner nerve loop consists of the anterior palatine and naso-palatine branches of Meckel's ganglion, and supplies the hard palate on one side and the soft tissues covering it. These various nerves may be blocked and anesthesia over their distribution produced by injecting at the following points:

**Maxillary Tuberosity.**—Injection here will block the superior dental or superior alveolar nerve, which supplies the upper molar and sometimes the premolar teeth.

**Technic.**—The lip and cheek are held away with the index finger of the left hand, and the patient is told to partly close the mouth in order to relax the cheek. The one and a half inch needle pierces the gum at the middle of the posterior buccal root of the second molar, and continuously injecting, is passed upward and backward in the direction of the apex of the third molar for about 2 cm., the point of the needle being all the time kept close to the bone (Figs. 320, 327

and 328). One or two c.c. of the solution are deposited. In about ten minutes, the molar teeth will be anesthetized, and will remain so for about one hour. However, the bone and soft tissues on the palatal side are supplied by the anterior palatine nerve, and this must be blocked to insure an absolutely painless operation in this region.

**Posterior Palatine Foramen.**—An injection at this point blocks the anterior palatine nerve and produces anesthesia of the hard

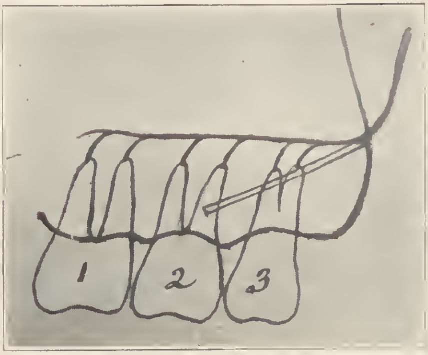



Fig. 327.—Diagram of position of needle for tuberosity injection.

Fig. 328.—Injection of posterior superior dental nerve at tuberosity of maxilla.

palate as far forward as the canine tooth. The short needle is inserted into the mucous membrane about 1 cm. to the palatal side of the second molar and directed slightly backward toward the third molar. Only three to five drops of solution are injected (Figs. 319 and 329).

**Infraorbital Foramen.**—Injection at the infraorbital foramen blocks the peripheral distribution of the infraorbital nerve and the

anterior superior dental nerve, producing anesthesia of the teeth, the buccal mucous membrane, and the bone, from the canine to the central incisor.

**Technic.**—The one and a half inch needle is used. The tip of the index finger of the left hand is placed over the region of the infraorbital foramen, about 1 cm. below the middle of the lower orbital margin, and the upper lip is raised with the thumb. The needle pierces the mucous membrane in the fold of the vestibule of the mouth, well away from the bone, above and behind the apex of the first premolar tooth, is passed directly upward, gradually approaching the bone, reaching the latter in the region of the infraorbital foramen, where one to two c.c. of fluid are injected (Figs. 317 and

Fig. 329.—Injection of anterior palatine nerve at posterior palatine foramen.

330). Massage over this point will force some of the solution into the infraorbital canal and infiltrate the anterior superior dental nerve. Complete anesthesia requires from five to ten minutes. It is possible in some cases to force the solution back into the infraorbital canal far enough to anesthetize the first premolar tooth. In operating near the median line, in addition to the infraorbital injection, it is well to infiltrate locally just at the median line, to anesthetize nerve fibers crossing over from the opposite side.

**Incisive Fossa.**—Injection at this point blocks the naso-palatine nerve, and gives anesthesia of the anterior portion of the palate, immediately behind the incisor teeth.

**Technic.**—The needle pierces the gum just posterior to the incisive

papilla, immediately behind the central incisors, passes upward and backward, and enters the fossa. Three to 5 drops of the solution are deposited as the needle proceeds upward (Figs. 318 and 331).

By means of these four injections, anesthesia of the entire upper

Fig. 330.—Injection at infraorbital foramen.

Fig. 331.—Injection of naso-palatine nerve at incisive fossa.

alveolar process with the teeth is brought about, with the exception sometimes of the premolar teeth, which then require an additional infiltration.

In addition to injection, anesthesia of the region of the upper central incisor teeth may be aided by the insertion of a plug of cot-

ton saturated with a 20 per cent novocain solution into the nostril on the side to be operated upon. This topical application will anesthetize the muco-periosteum and bone in the floor of the nose.

**Conduction Anesthesia in the Mandible.**—It is in operations on the lower jaw that conduction anesthesia finds its greatest field of usefulness. Blocking the inferior alveolar nerve at the mandibular foramen produces anesthesia of the teeth, alveolar process and gum tissue of one-half of the lower jaw, with the exception of an area of gum tissue on the buccal side of the molar teeth, which is partly supplied by the long buccal nerve, the mucous membrane on the lingual side of the teeth, partly supplied by the lingual nerve, and the anterior portion of the mandible, including the incisor teeth, which is supplied in part by overlapping fibers of the nerve from the opposite side.

**Injection at the Mandibular Foramen.**—Several methods of performing this injection have been proposed, but we prefer the technic described by Blum. In the first place, the operator should if possible get accustomed to standing in front of the patient in making the injection, and use the index finger for palpation of the bony landmarks. For injection of the foramen on the right side, the left index finger is used for palpation, and the right hand holds the syringe. In injecting the left side, the right index finger palpates and the left hand holds the syringe. Injection of the right side will be described. The index finger of the left hand is placed in the buccal fold alongside the last molar tooth. The ball of the finger comes in contact with a prominent ridge, the external oblique line, which lies just postero-externally to the last molar. Turning the finger point inward and downward, the ball of the finger will fall into a depression, the retromolar triangle, while the finger nail touches the ill-defined internal oblique line. This line is situated mesioposteriorly to the external oblique line, and the two form with the last molar tooth as the base, the retromolar triangle. The finger is slightly retracted, and the mucous membrane painted with iodine-ether solution. The syringe, with one and a half inch needle, is grasped with the right hand, like a pen, and the point inserted just to the inner side of the edge of the finger nail, 1 cm. above the level of the occlusal surfaces of the molar teeth, until it strikes the internal oblique line (Fig. 322). The syringe and needle are almost directly in a sagittal plane, on a line parallel with the molar teeth, but somewhat external to them. The tendency of beginners is to inject too near the median line. After striking the

internal oblique line, the needle is retracted slightly and moved mesially to overcome this obstruction, then passed slightly backward to the inner aspect of the ascending ramus. Here about 0.5 c.c. of the solution is injected, to anesthetize the lingual nerve, which crosses the ramus at this point. The point of the needle is now brought in contact with the inner surface of the ascending ramus by bringing the barrel of the syringe to the premolar region of the opposite side (Fig. 323). The needle, kept in contact with the bone, then passes backward for about two cm. altogether, when its point enters the mandibular sulcus and the remainder of the solution (about 1.5 c.c.) is injected (Fig. 324).

To anesthetize the left side, the right hand is used as a guide, the syringe being held with the left. Those who are unable to use the left hand for making the injection, should stand behind the patient in injecting the left side, palpating the parts with the index finger of the left hand, and holding the syringe with the right.

In a few minutes, upon questioning, the patient will state that the lip and tongue are beginning to have a peculiar feeling, at first a tingling, or swollen sensation, which gradually develops into distinct numbness. In almost every case the molars, premolars and canine are completely anesthetized in from ten to twenty minutes. Before starting to operate, the mucous membrane is tested with a pair of pliers buccally and lingually. If, after twenty minutes, pain is still felt in the canine region, a second mandibular injection must be given. In case the buccal mucous membrane in the molar and premolar region is still sensitive, this part must be desensitized by a horizontal injection in the apical region of these teeth to block the fibers of the long buccal nerve. In infected cases, this nerve may be blocked by injection in the mucous membrane of the cheek. Mandibular anesthesia may last from one to two hours.

The incisor teeth and corresponding bone are not completely anesthetized by injection at the mandibular foramen, owing to partial innervation from the nerve on the opposite side. To obtain complete anesthesia of half of the lower jaw the nerve to the incisor teeth at the mental foramen on the opposite side must also be injected, and a deposit is also made lingually at the median line to block the opposite lingual nerve fibers.

In making the mandibular injection, the operator should never insert the needle less than 0.75 cm. nor more than 1 cm. above the occlusal plane of the lower molar teeth. If the injection is made too low one of three things may happen: (1) The lingula may prevent

farther advance; (2) the lingula and spheno-mandibular ligament may direct the needle mesially into the internal pterygoid muscle, causing trismus from infiltration of the muscle; (3) the inferior dental nerve may have entered the canal and will not be reached. At a point higher than 1 cm. above the molar teeth, the inferior dental nerve is at some distance from the inner surface of the ramus, and may be missed.

The essential and cardinal point about mandibular injection is that the point of entrance of the needle should be *within* the retromolar triangle. The beginner always goes too far mesially. This mistake will be avoided if the needle is made to strike the internal oblique line immediately after penetrating the mucous membrane, and its point kept in close relation to the bone during its entire course backward.

**Mental anesthesia** is indicated for operations on the premolars, canine and incisors, and as an adjunct to mandibular injection to exclude innervation from the opposite side.

**Technic.**—Pierce the mucous membrane of the lower lip near the bottom of the vestibular fold and below the second premolar, proceed downward and slightly forward—the foramen faces slightly posteriorly—to a point midway between the lower border of the jaw and the alveolar margin, to reach the foramen (Fig. 321). Inject one c.c. in this region, and follow by massage with the finger. The tissues will remain anesthetized for about one hour.

## DANGERS, ACCIDENTS AND COMPLICATIONS OF LOCAL ANESTHESIA WITH NOVOCAIN

If proper preparation of solution, syringe, and needles has been carried out, and the technic followed as described above, untoward incidents should seldom occur during or after the injection of the local anesthetic. However, one should be in a position to cope with complications in the rare cases when they arise.

**Idiosyncrasy.**—Although in the amounts ordinarily employed, symptoms of poisoning after injection of novocain are very seldom seen, it should never be forgotten that novocain is a toxic agent and that if an excessive dose is employed serious symptoms may appear. When these symptoms occur with an unusually small dose the patient is said to have an idiosyncrasy for the drug. Hypersensibility to the toxic action of novocain is very seldom seen, in marked contrast to cocain in this respect. In patients who complain of palpitation al-

most immediately after introduction of the needle, or who exhibit cyanosis or pallor, caution is required in making the injection. Only a few drops of the solution should be injected at first in cases suspected of idiosyncrasy. Toxic symptoms may be due to adrenalin rather than to novocain.

**Shock and Collapse.**—In nervous patients, fear of the operation will sometimes produce psychic shock even before the needle is introduced. It is not uncommon to see patients show pallor, cold moist skin, rapid pulse, dizziness, faintness, and even loss of consciousness, right after the injection. These symptoms, except in the very rare cases of idiosyncrasy, have nothing to do with the drug, but are purely psychic. This is borne out by the fact that ten times the amount of novocain is frequently injected in general surgical operations without ill effects, under the more favorable psychic conditions of the hospital. *Treatment* of psychic shock consists in lowering the head, either by tipping the patient back to a horizontal position, or forcing the head down between the knees. This immediately restores the circulation in the head and upper part of the body. It is advisable to admit some fresh air by opening the window. The patient is then allowed to inhale a few drops of aromatic spirits of ammonia or amyl nitrite, and after consciousness is restored, to swallow a dram of aromatic spirits of ammonia in a little cold water. After recovery from the milder forms of shock, it is usually possible to proceed immediately with the operation.

**Breaking the Needle.**—This accident occurs occasionally, especially during mandibular injection, the broken portion of the needle disappearing in the tissues so rapidly that it cannot be recovered. Breakage may be due to several causes, such as the use of a rusty needle, faulty technic causing undue bending of a fine needle, or a sudden movement of the head by the patient. An iridio-platinum needle may be broken as readily as a steel one. Needles with a so-called safety guard give an undue sense of security to the operator, and should not be used, because these needles are just as prone to break distal to the guard as proximal to it. In guarding against this accident, care should be taken that the needle is not defective from rust or bent from overuse. If proper technic is used in making the injection, this accident will very rarely happen, especially if the needle recommended above be employed. This is a 22-gauge steel needle, one inch and a half in length.

The broken needle in the tissues may give rise to no immediate

trouble. The patient may not be aware of its presence, but it should always be removed if possible, as it may give rise to pain, trismus and infection later. Removal of the needle, though often easy, may develop into a serious operation, and should therefore be performed by an experienced surgeon. As a preliminary, the needle should be accurately localized by antero-posterior and lateral radiographic plates, or stereoscopically. One useful method of localization is to

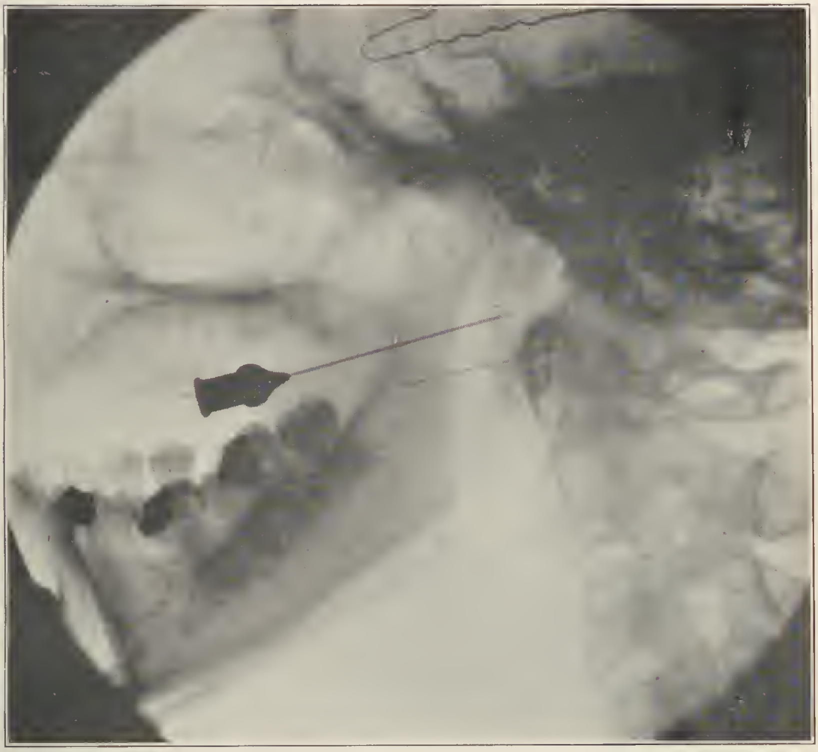


Fig. 332.—Lateral radiogram for localization of broken needle on inner aspect of ramus. The upper needle has been inserted for better localization of the broken needle.

insert another needle as near as possible to the broken one and then to make lateral and antero-posterior x-ray plates with the new needle in position (Figs. 332 and 333). The position of the broken needle can then more easily be determined by comparison with that of the second one. Removal of the needle can best be attempted under local anesthesia. An incision is made through the mucous membrane and underlying tissues over the inner surface of the ramus, at right

angles to the direction of the needle, and at about the middle of the latter. In this way, the knife blade should come in contact with the needle. After recovery of the needle, the wound can generally be sutured.

**Postoperative pain** may be due to the following conditions: sharp splinters of bone, sloughing of the margins of the wound, injection of non-isotonic solutions or those containing irritating agents, insufficient disinfecting of the field of operation, infection from unclean instruments, etc., all of which can be averted by proper precautions. If the anesthetic solution has been prepared properly, and the injection correctly performed, no postoperative pain is to be expected from this source.

Fig. 333.—Antero-posterior radiogram for localization of broken needle.

Postoperative pain is relieved or prevented by internal administration of acetyl-salicylic acid (aspirin), ten grains, repeated in three

hours if necessary. For very severe pain, one-sixth of a grain of codein may be given every two hours by mouth for not more than three doses. It may become necessary to give a hypodermic injection of one-fourth of a grain of morphine. A hot water bag applied to the face will give some comfort. Packing the wound with novocain powder in balsam of Peru gives surprising relief in many cases.

**Postoperative hemorrhage** due to the injection of the local anesthetic is very rare. There is often some slight bleeding one or two hours after the injection, due to the reaction following vaso-constriction by the adrenalin, but this usually requires no treatment. If

Fig. 334.—Loss of tissue through entire thickness of cheek from slough following injection of irritating fluid in mistake for local anesthetic solution.

severe, the hemorrhage is to be treated in the same manner as any postoperative hemorrhage, by packing the wound with gauze saturated with thrombo-plastin, tannic acid powder, or some other styptic.

**Hematoma.**—Puncture of a small vessel with the needle occasionally occurs, producing a hematoma. In this case, the injection is immediately followed by a swelling, rapidly increasing in size to a certain point. The amount of blood escaping is usually self-limited by the pressure produced. No treatment as a rule is required, except perhaps the use of an ice-cap and pressure of a bandage. In case of a large collection of blood it might become necessary to incise, evacuate and pack the cavity.

**Infection, sloughing, gangrene and necrosis** following the injection of a local anesthetic, can in every case be traced to some error in technic, such as stale and infected solution, lack of sterility of the needle and syringe, irritating chemicals in the solution, such as phenol or formaldehyde, or injudicious injection directly into a focus of infection (Fig. 334).

**Unduly prolonged duration of local anesthesia** has been observed after the injection of novocain. This cannot be ascribed to the action of the novocain, but to either (1) injury of the nerve by the needle or during the operation, more often the latter, or (2) presence of alcohol in the syringe at the time of injection. Those who keep their syringes and needles in alcoholic solutions should take care to wash out all of the alcohol before filling the syringe with the anesthetic.

## GENERAL ANESTHESIA

In surgery of the face, mouth and jaws, general anesthesia is indicated in preference to local under certain conditions. The principal conditions are:

1. Cases of infection in which it is impossible to inject a local anesthetic except into acutely inflamed tissues.
2. Where muscular relaxation is required to overcome trismus.
3. In children and nervous adults who cannot be controlled under a local anesthetic.
4. Prolonged and extensive operations where duration and amount of tissue involved are beyond control by local anesthetic.

The principal general anesthetic agents employed in oral and facial surgery are nitrous oxide, ether, and combinations and sequences of these with each other and with oxygen. Chloroform and ethyl chlorid are also used under exceptional circumstances.

**Nitrous Oxide.**—Ever since its introduction, nitrous oxide has been the favorite anesthetic for the extraction of teeth. For this purpose it has been generally administered alone, though of late years combination with oxygen has greatly enlarged its possibilities.

Nitrous oxide produces anesthesia by its direct physiologic effects upon the brain cells, and not by causing asphyxia, as was formerly supposed. It does, however, produce asphyxia when it is inhaled without being mixed with oxygen or atmospheric air. When inhaled, the gas is dissolved in the blood, but does not form a new chemical compound with the hemoglobin, nor is it decomposed in the body. If its administration is continued sufficiently long without oxygen being

permitted to enter the patient's lungs, death takes place from its direct depressant effect upon the respiratory center, but chiefly from lack of oxygen.

Given with a correct proportion of oxygen, nitrous oxide ranks above ether or chloroform so far as safety to life is concerned. In point of after-effects it takes precedence over all other agents, since it is practically free from sequelae if administered with a fair degree of care. Nitrous oxide is pleasant to take, anesthesia is quickly induced by it, and it seldom has any unpleasant after-effects.

Blood pressure is always increased when nitrous oxide is given alone. With judicious use of oxygen, nitrous oxide anesthesia may be continued for a sufficient time to permit the performance of any ordinary surgical operation with very little variation in blood pressure.

**Indications and Contraindications.**—Nitrous oxide alone is very limited in its indications, in fact, at this stage of development of methods of administration it is practically never indicated. Nitrous oxide and oxygen as an anesthetic is contraindicated in children under four years of age, because of their immature musculature, which makes breathing in the bag difficult. It should be used with caution, and only by a skilled administrator in old persons, or those with a generally weakened musculature, in adults of whatever age whose arteries are sclerosed, in advanced pulmonary tuberculosis, in valvular disease of the heart, in cases where there is great swelling of the neck, or any obstruction of the air passages, such as enlarged tonsils or adenoids. In strong, muscular, athletic, alcoholic and obese subjects, the induction of anesthesia with nitrous oxide is often very difficult.

For short operations about the mouth, such as extraction of teeth, opening abscesses, etc., nitrous oxide, combined with oxygen, is a suitable anesthetic. With the use of the face mask, the time available for operation within the mouth is not more than half a minute, because the anesthetic must be withdrawn while operating. With the use of the nasal inhaler more prolonged operations within the mouth may be successfully undertaken, because it is then possible to continue the administration of the anesthetic during the operation. However, this method has many disadvantages as compared with local anesthesia for intraoral operations. With the development of modern local anesthesia, nitrous oxide has ceased to be the anesthetic of choice for extraction of teeth and other mouth operations, and is reserved for cases in which for some reason local anesthesia is not suitable.

As a dental anesthetic nitrous oxide is not nearly so important as it was ten years ago. While at that time it was regarded as an indispensable part of every dentist's equipment, at the present time he can easily get along without it if trained in local anesthesia. In these days, when it is recognized that mere extraction of a tooth does not necessarily cure disease that may be present in the surrounding alveolar process, which demands surgical treatment as well, local anesthesia has great advantages over the short nitrous oxide anesthesia, which is usually accompanied by more or less profuse bleeding from the wound, and other factors which obscure the field of operation. In oral surgery, therefore, nitrous oxide should be reserved for cases of acute infection where the injection of a local anesthetic is inadvisable, and for children and nervous adults. In mouth cases complicated by trismus, nitrous oxide with oxygen is not suitable, as complete muscular relaxation cannot be brought about by it.

In more or less prolonged operations on other parts of the body the combination of nitrous oxide and oxygen is very useful in cases where other anesthetics such as ether and chloroform are contraindicated, and with some surgeons it is the anesthetic of choice for the majority of operations. When skillfully administered, it is undoubtedly the safest of all anesthetics.

**Stages of Anesthesia with Nitrous Oxide and Oxygen.**—When nitrous oxide is administered with a suitable amount of oxygen, so that the duration of the anesthetic period can be prolonged at will, it is possible to note definite stages just as in the case of other inhalation anesthetics. The course of the anesthesia is smooth and practically featureless.

The *first stage* is marked by a sort of numbness in the limbs and other parts of the body, quickly followed by a feeling of exhilaration. There is an impulse to breathe more rapidly and more deeply. The pulse grows fuller, the blood pressure is raised. Twenty or 30 seconds is the average duration of this stage.

The *second stage*, or stage of excitement, is initiated with loss of consciousness. Incoherent thoughts and words, and purposeless muscular movements, particularly of the arms and legs, are apt to occur. The pulse is still full, and somewhat more rapid and deeper than normal. Swallowing movements, and sometimes stertor, are noted. The pupils become dilated, the eyelids twitch. The skin becomes dusky.

The *third stage*, or stage of surgical anesthesia, is induced in from one to four minutes. Breathing should be automatic, regular and with-

out noise. The pulse is full and regular, and slightly increased in rapidity. The duskiness of the skin should not be increased in degree as anesthesia advances. The eyelid and other reflexes are abolished, and there is partial muscular relaxation, though seldom of the jaw muscles. Maintenance of this stage of anesthesia requires a careful balance in the proportion of the nitrous oxide and oxygen. The automatic breathing, with or without stertor, the widely dilated or contracted pupils (varying with the preliminary medication), full and regular pulse, with a slight degree of cyanosis, indicate the third stage. Two or three stertorous respirations indicate complete anesthesia.

The *fourth stage*, or stage of overdose, supervenes through some error of technic by which asphyxia becomes the predominant feature of the narcosis. Breathing becomes embarrassed, usually through convulsive muscular spasm. The interference with respiration is first marked by hyperpnea (excessive breathing), then by dyspnea (difficult breathing). Violent or convulsive expiratory efforts, sometimes accompanied by general muscular spasms, mark the second stage of asphyxia. Following this there is a stage of exhaustion in which muscular spasm is superseded by muscular relaxation. The pupils become more widely dilated, the conjunctivae are insensitive. The pulse becomes imperceptible, respirations gradually cease. Marked cyanosis accompanies this condition of affairs.

**Administration of Nitrous Oxide.**—Nitrous oxide is preferably given on an empty stomach. Before administration of nitrous oxide and oxygen for extraction of teeth or other intraoral operation, the clothing about the neck and waist of the patient should be loosened, and removable artificial teeth or other foreign bodies taken from the mouth. Whether the face-mask or the nasal inhaler be used, a cork or rubber prop should be placed between the teeth on the side opposite to that upon which the operation is to be performed. The patient is instructed to take slow, full breaths, and is made to go through several full respirations of this character with the face-piece over the face or the nasal inhaler in place and the air valve open. When proper breathing has been established, the gas is turned on, pure nitrous oxide at first, and the air excluded, when the nasal inhaler is used, by holding the hand or a rubber sheet over the mouth. Oxygen is gradually added to the nitrous oxide in just sufficient quantities to eliminate cyanosis, muscular twitching and stertor,—usually from 4 to 10 per cent. The signs that full anesthesia is reached are those noted under the third stage. A good guide is the falling of the

upheld arm of the patient to the side. When this occurs, the face-mask is removed, or administration is continued through the nasal inhaler, and the operation is quickly performed. After withdrawal of the anesthetic, the patient gradually recovers full consciousness within three to five minutes. As a rule, there are no disagreeable after-effects. In some cases, where anesthesia has been prolonged, vomiting may occur. The patient should rest quietly until recovery is complete.

There are many forms of apparatus on the market for the administration of nitrous oxide and oxygen, with devices for regulating the percentages of the gases. Some of these are quite simple, and others complicated. In controlling the amount of oxygen to be used, the color of the patient and other clinical sign should be used as guides rather than the reading of percentages on the graduated scale.

Prolonged anesthesia with nitrous oxide and oxygen or ether is greatly aided by the preliminary administration hypodermically of morphine. It has been found recently that administration of magnesium sulphate with the morphine greatly adds to the efficiency of the latter and decreases the amount of anesthetic necessary, whether it be nitrous oxide or ether. One hour before the operation, one-eighth of a grain of morphine is given in 1 c.c. of 25 per cent solution of magnesium sulphate. This dose is repeated half an hour later.

**Ether.**—Ether is the anesthetic of choice in most operations requiring prolonged anesthesia, on account of its comparative safety and its production of complete muscular relaxation. In dental and oral surgical practice, it is suitable for all operations that cannot be performed under nitrous oxide or local anesthesia, such as those requiring a long period of time, or where it is necessary to overcome trismus. Ether is not suitable for office practice, owing to its disagreeable after-effects and the length of time required for recovery. Contrary to chloroform, ether can be safely administered with the patient in the sitting posture. It is not so pleasant to take as chloroform, requires a longer time for anesthesia, and is more irritating to the respiratory tract and the kidneys, but these facts have little weight against the dangers of chloroform. Ether causes a rise of arterial pressure by stimulating the vasomotor center and also by stimulating the heart. In moderate amounts, there is an increase in the force and frequency of the pulse. In large doses ether becomes a cardiac depressant. In poisonous amounts, ether causes death by failure of the respiratory center. Ether is eliminated in large part by the lungs and partly by the kidneys, upon which it acts as an irritant. It must

not be forgotten that ether is highly inflammable and great care must be taken to avoid using it near an open flame, as a lighted gas jet, or a burning candle or stove. In using the cautery about the mouth, the ether should be previously withdrawn.

**Stages of Ether Anesthesia.—**

*Ether anesthesia may be divided into four stages, as follows:*

1. Stage of primary anesthesia or analgesia.
2. Stage of excitement.
3. Stage of muscular relaxation or surgical anesthesia.
4. Stage of collapse.

*First Stage.*—On first inhalation of ether, there is burning in the throat and a feeling of strangulation due to local irritation of the ether. In a short time sensibility becomes distinctly lessened, and the patient becomes semiunconscious. In this stage, minor operations, such as extraction of a tooth or opening of an abscess, can be performed without pain.

*Second Stage.*—The first stage is soon succeeded by the stage of excitement. The patient becomes delirious and often violent. The muscles are rigid; the respirations are rapid, though they may cease through spasm of the glottis; the face is flushed and moist. Reflexes are present and may be exaggerated. The pulse is rapid and full. The pupils are dilated and responsive to light.

*Third Stage.*—In this stage the patient becomes quiet. The muscles are relaxed; the corneal and other reflexes are lost. The pupil is contracted. The breathing is slow, deep and regular. The pulse is full, strong and slow. The skin is flushed, warm and moist. This is the stage during which surgical operations are performed. Production of complete surgical anesthesia requires, as a rule, from ten to fifteen minutes.

*Fourth Stage.*—If anesthesia be carried beyond the third stage, the patient's life is in danger from collapse. The breathing becomes stertorous from paralysis of the muscles of the soft palate. The respirations then become shallow and irregular, or may cease altogether. The pupil dilates and will not respond to light. The pulse becomes rapid and weak. The skin is cold, moist and dusky. Death is due to asphyxia.

**Administration of Ether.—**

*Primary Anesthesia or Analgesia.*—Extraction of a tooth or opening of an abscess can often be performed during the first stage of ether anesthesia. In these cases little or no previous preparation of the patient is necessary, and the patient may be in the sitting

posture. The best way of giving the ether in these cases is by means of a towel folded into the shape of a cone, in which a sponge moistened with warm water is inserted. A considerable quantity of ether is poured on the sponge and the face of the patient gradually approached with the cone. The patient is instructed to take full breaths and hold up one arm. In a few minutes the arm drops and the operation is performed without pain. This method is reserved for very short operations when nitrous oxide is not available and local anesthesia is contraindicated.

*Preliminary Preparation for Prolonged Anesthetization.*—No food should be taken by the patient for at least six hours before the administration where a long operation is to be performed. If this precaution be not observed, vomiting is liable to occur, with interruption of the operation, danger of suffocation and aspiration pneumonia. A purgative should be given the night before the operation, and an enema in the morning. The patient's heart and lungs should be carefully examined, and the blood pressure taken. The urine should be examined. Ether is a powerful irritant to the kidneys, and the minimum amount must be used in the presence of nephritis. Preliminary hypodermics of morphine and magnesium sulphate are given as described under prolonged nitrous oxide anesthesia.

Just before beginning administration of the anesthetic all foreign bodies, such as removable artificial teeth, should be taken from the mouth, to avoid danger of inspiration into the respiratory passages. The clothing about the neck and chest must be loosened to permit free respiratory movements. The horizontal position is preferred in administration of the anesthetic, but the patient can be placed later in any more convenient position for the performance of the operation. The patient should have a low pillow under the head. The lips and nostrils should be anointed with vaseline, to avoid irritation by the ether.

It is customary sometimes to first anesthetize the patient with nitrous oxide, and then continue with ether. This method is more agreeable to the patient and the period of induction is much shortened. Most modern nitrous oxide apparatus is furnished with an attachment whereby ether can be gradually turned on without interruption. In the hands of those without special training, however, better results will be obtained as a rule by beginning with ether. If the ether be given slowly, it is seldom objected to by the patient.

*Open Drop Method.*—In the hands of those with comparatively little experience, this is the safest and most satisfactory method of giving ether. There is little danger of asphyxiating the patient, as plenty of air necessarily is administered. About six layers of gauze are placed on a wire mask and a few drops of ether allowed to fall on them. The mask is held at first some little distance from the patient's face, and gradually made to come nearer, until finally the fumes become tolerable and it can be laid directly in contact with the face. After this the ether can be given more rapidly, but still drop by drop, and, if necessary, more layers of gauze applied. By this open method, with slow administration of the ether, and allowing admixture of plenty of air, a longer time is required for anesthesia than when ether is given in larger amounts and excluding the air, but relaxation becomes more complete, and the general condition of the patient is much better throughout the operation. The patient is instructed to breathe deeply and regularly, but forcible respiration is to be avoided. Any cessation of respiration during the early stages is due to local irritation or spasm of the glottis. A full breath of air, followed by an increase in the amount of the anesthetic, is generally successful in restoring natural respiration. The lower jaw should be kept forward by pressure of the fingers behind the angle. This prevents the tongue from falling back and obstructing the glottis. During the stage of excitement the patient may become so violent as to require assistants to hold him. When the patient is quietly resting on the operating table, the arms should be secured to the sides by a towel passed under the body, the ends being fastened to the wrists with safety-pins, or the hands pushed under the buttocks. This prevents the arms from hanging over the sides of the table, and consequent risk of musculo-spiral paralysis from pressure on the nerve by the edge of the table.

The indications that anesthesia is complete are relaxation of the muscles and absence of the corneal reflex. During the operation the anesthetist must from time to time note the condition of the pulse, and report it to the operator. The pulsation of the temporal artery can be conveniently felt immediately in front of the ear. Any mucous which may collect in the throat should be removed by means of a gauze sponge. Respiration may be aided by inserting a mouth-gag, drawing the tongue forward, and holding it with a small piece of gauze between the fingers. This is preferable to the tongue forceps, which crush and wound the tongue unnecessarily. If an instrument

becomes necessary to draw the tongue forward, the ordinary Backhaus towel clamp causes practically no wound of the tongue and is quite as efficient as any of the special tongue forceps. During the operation the patient is kept under with the minimum amount of ether, continually administered drop by drop. A slight break in the regularity of the breathing is an indication, as a rule, that the patient is coming out, and to push the anesthetic a little. During deep anesthesia the pupil is contracted; as it becomes less profound, the pupil dilates, but will respond to light. When the ether is pushed too far, the pupil also dilates, but does not respond to light. The depressant effects of the ether also show themselves in a duskiness of the skin, due to sluggish circulation. This can be conveniently observed in the lobe of the ear. Cyanosis is accompanied by gradual acceleration in the pulse rate and a decrease in its volume. These signs call for stimulation and termination of the operation as quickly as possible.

The anesthetic may be withdrawn several minutes, as a rule, before the operation is completed and may be replaced with oxygen or aromatic spirits of ammonia. Careful watch should be kept over the patient recovering from prolonged anesthesia, as vomiting almost invariably occurs, and the respiratory passages must be kept clear of vomited material. This is best guarded against by keeping the head turned to one side. There may also be a tendency for the tongue to fall back and obstruct the glottis, which is best prevented by keeping the tongue and jaw forward.

**Accidents and Complications Occurring During General Anesthesia.**—These remarks apply to any agent, whether ether, chloroform, or nitrous oxide.

*Circulatory Failure.*—If the circulation becomes sluggish, with increasing weakness and rapidity of the pulse and duskiness of the skin, strychnine sulphate, one twentieth of a grain, and tincture of digitalis, 10 minims, or camphorated oil, 15 minims may be given hypodermically. In more extreme cases, with the pulse at 160 or higher, especially when the patient has lost a considerable amount of blood, intravenous infusion of a pint or more of normal saline solution is indicated, or transfusion of blood from another person. Sudden cardiac failure during anesthesia calls for cardiac massage, or preferably the injection of 1 c.c. of a 1:1000 solution of adrenalin chlorid directly into the heart muscle, through a long needle inserted in the fourth interspace just to the left of the sternum.

*Vomiting* during the operation is usually a sign that the anesthesia is not sufficiently deep. Its onset is heralded by retching, and it can often be averted by pushing the ether. If vomiting does occur, remove the mask and turn the head of the patient to one side to prevent inspiration of the vomited material. As soon as possible after the throat has been cleared the administration of the anesthetic is continued.

*Respiratory Failure.*—In case of respiratory failure, remove the anesthetic at once, see that the tongue has not fallen back to obstruct the glottis, and attempt to set up respiratory movements by pressure on the chest. A piece of gauze saturated with aromatic spirits of ammonia placed over the nostrils will often be of assistance. If these measures fail, regular artificial respiratory movements should be tried. Administration of oxygen with the ether in all cases that show a tendency to respiratory embarrassment should be a regular procedure.

**Special Methods of Administration.**—For operations within the mouth or about the head and neck various forms of apparatus have been devised for introducing the anesthetic into the respiratory passages without interrupting the operation. With the open mask method, after the patient is fully anesthetized, it is necessary to remove the mask to gain access to the field of operation. After a time the effects of the anesthetic begin to pass off, and it becomes necessary to interrupt the operation to administer more anesthetic. Also, blood and mucus from the mouth are apt to be drawn into the respiratory passages. These drawbacks are overcome by the vapor method, by which air, oxygen or nitrous oxide pass over the ether, the ether being thus vaporized before being delivered to the patient. This distinguishes it immediately from the drop method, in which the anesthetic is placed on gauze and is vaporized by the patient. The essential features of an apparatus for vaporizing ether are as follows: A hand bulb, foot bellows or electric pump force air through a bottle containing ether, and the air and ether vapor are then carried through a tube to the patient. Between the ether bottle and the patient is an empty bottle as a safeguard to catch any liquid ether which may be forced over. Vaporization is favored by setting the ether bottle in warm water. The patient may receive the ether vapor through a tube in the mouth (intraoral method), through tubes passed into the pharynx through the nose (intrapharyngeal method) (Fig. 335), or through a tube passed through the mouth directly

into the trachea (intratracheal method). Before employing any of these vapor methods, complete anesthesia should first of all be induced by the open drop method or by the nitrous oxide-oxygen-ether sequence. The intraoral method may be used for short operations within the mouth or for operations on the nose where it would be difficult to apply the nasal tubes.

The intratracheal method is preferred by some surgeons for all operations about the head, neck and chest. By this method it is possible to keep the lungs distended and practically abolish respiratory movements, which is a great advantage in intrathoracic operations. On the other hand, it requires considerable practice to introduce the tube into the trachea, and complicated apparatus is necessary to maintain the proper pressure of ether vapor and air. This form of administration is practically never necessary in operations

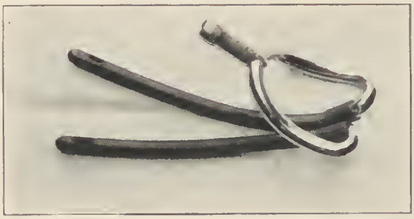


Fig. 335.—Catheters attached to Y-tube for carrying vaporized ether through nose to pharynx.

about the face, mouth and jaws, the simpler intrapharyngeal method being adequate in these cases.

The *intrapharyngeal method* of administration of ether is the method of choice for all long operations about the face, mouth and jaws. The patient is first fully anesthetized by the open drop method or by the nitrous oxide-oxygen-ether sequence. No. 18 soft rubber catheters are passed through the nostrils back as far as the pharynx and connected to the vaporizing apparatus by means of a metal Y-connection. They are secured in place with a strip of adhesive plaster fastening the Y-connection to the forehead. The proper length for the catheters is the distance from the nostril to the external ear. After adjusting the tubes, the entire head and face except the part to be operated upon can be covered with sterile towels, and the field of operation thus isolated and free from interruption by the anesthetist. The tongue should be secured by a towel clamp and drawn forward. If the operation is within the mouth, the back part

of the mouth can be packed with gauze to prevent inspiration of blood and mucus, without danger of obstructing the respiration. It is of great advantage, instead of using a bellows or air pump, to attach an oxygen tank to the ether bottle, permitting the bubbles of oxygen to carry the ether vapor to the patient, so that the patient is getting ether and oxygen instead of ether and air. By this means there is less cyanosis, less mucus, and less respiratory embarrassment. The cost of operation by this method is greater than with the air pump. The desired object may be very satisfactorily attained by connecting the intrapharyngeal tubes to a nitrous oxide-oxygen apparatus furnished with an ether attachment. By this means the patient can be kept under largely by nitrous oxide, and a minimum amount of ether used.

*Ether-oil Colonic Administration of Ether.*—This is another method that is used extensively in some hospitals for operations about the head, but with which we have had no personal experience. By this method the patient is put to sleep before the operation and there is no interference during the operation by administration of the anesthetic. On account of the gradual and equal absorption of ether from the colon, and its rapid evaporation from the lungs, it is a comparatively safe anesthesia, provided the same care and attention are given to details as with any inhalation anesthetic. The preliminary preparation of the patient is important, and is as follows: A cathartic of castor oil should be given the night preceding the operation, followed in the morning by warm water enemas one hour apart until the return is clear. One hour before the introduction of the anesthetic mixture, two to four drams of paraldehyde in an equal amount of olive oil are given very slowly through a funnel and tube passed four inches into the rectum. Half an hour before the introduction of the anesthetic mixture, a hypodermic injection of $\frac{1}{6}$ grain of morphine and $\frac{1}{150}$ grain of atrophine is given. The anesthetic mixture consists of a 75 per cent solution of ether in olive oil, which is introduced very slowly through the rectal tube. Eight ounces of the 75 per cent mixture will cause the anesthesia to last from two and a half to three hours. No more than eight ounces should ever be given. The anesthetic should take effect in ten to twenty minutes.

The anesthetist has good control of the ether at all times. If the patient approaches the danger zone, withdrawal of the mixture remaining in the colon will usually immediately remedy the trouble.

### Chloroform

Chloroform is a much more dangerous anesthetic than ether, because it more strongly and quickly depresses the circulation and respiration than ether. In its administration there is a progressive fall in blood pressure. Chloroform is much more pleasant to take than ether, produces less excitement, less irritation of the respiratory passages, its effects are much more quickly produced than those of ether, while there is usually less nausea and vomiting following its administration. All these advantages, however, are counterbalanced by the danger of chloroform and the comparative safety of ether, and there are only a few cases in which the latter is not to be preferred. In major operations about the face and mouth, chloroform is preferable to ether in cases of chronic bronchitis, asthma and pulmonary tuberculosis, as ether is a powerful irritant to the respiratory passages. At the present day, however, nitrous oxide and oxygen has largely replaced chloroform as an anesthetic under these conditions. The addition of a few drops of chloroform during the administration of ether in refractory cases or those exhibiting a great amount of mucus or respiratory irritation, is of considerable advantage, and may be resorted to judiciously without dangerous results.

**Delayed chloroform poisoning:** After long operations under chloroform, considerable qantities may become stored in the tissues, and may give rise to a condition known by this name. The symptoms come on after the patient has recovered apparently from the effects of the anesthetic and the shock of the operation. The symptoms resemble those of acid intoxication or acidosis. They may begin with vomiting, accompanied by restlessness and delirium, and succeeded by coma. Jaundice and albuminuria develop, and acetone and aceto-acetic acid are found in the urine. The lesions found at autopsy consist in fatty changes in the liver, kidneys, suprarenals, and epithelium lining the stomach.

**Administration.**—Chloroform is given by the open drop method, but in very much smaller amounts than in the case of ether. It is not necessary here to go into further detail.

### Ethyl Chlorid

Ethyl chlorid owes its popularity as a general anesthetic to its agreeable character, the rapidity with which it induces anesthesia, and the economy in its use. Anesthesia occurs in a few seconds, requiring 1 to 4 c.c. of the drug. It is usually employed for short

operations, in which the operation is done after the anesthetic mask has been removed, but it is doubtful whether its use is justifiable even in these cases, when we have an absolutely safe anesthetic in nitrous oxide for this kind of work. Statistics show that the mortality rate from ethyl chlorid is between 1 in 2000 and 1 in 3000.

The objections that apply to ethyl chlorid are applicable to the several proprietary combinations of the drug on the market at the present time, for the special use of the dental profession, e.g., somnoform, which is a mixture of ethyl chlorid 60 per cent, methyl chlorid 35 per cent, and ethyl bromide 5 per cent.

# INDEX

F



G



H

B